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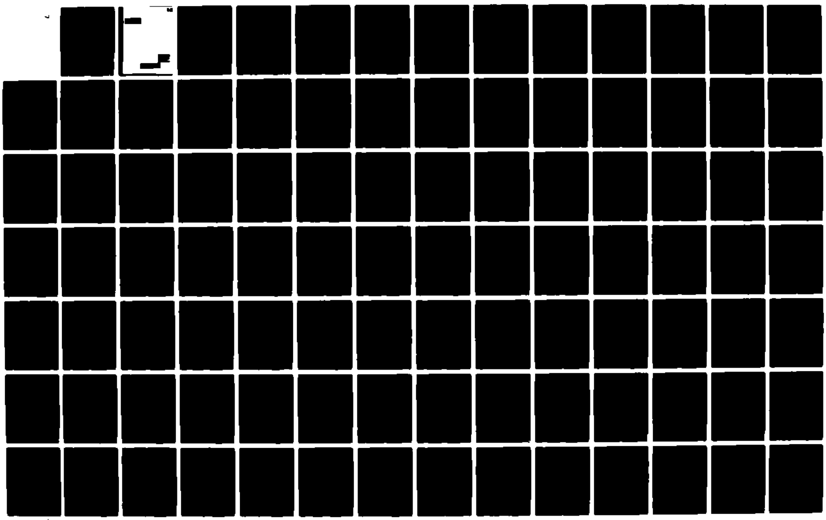

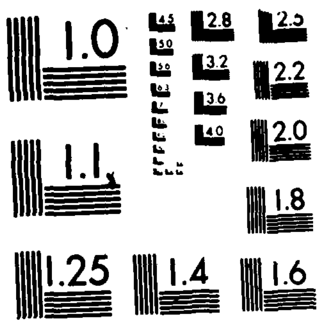
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Studies of a 210-square mile area including the Cape Girardeau-Jackson, Missouri metropolitan areas are addressed in this report. The problem of flooding along Cape La Croix Creek and Walker Branch in the City of Cape Girardeau (drainage area of 21.4 square miles) is addressed by the Recommended Plan. Environmental, outdoor recreation, and social well-being concerns have also been addressed. Flood control improvements for the remainder of the study area, including the city of Jackson and the rural area along the Little River Diversion Channel, are not economically justified at this time.

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The Recommended Plan has widespread public support; it reduces the total average annual flood damages by about 85%; and addresses the environmental and outdoor recreational needs. With implementation of the Recommended Plan of improvements, the flood damages normally expected to result from a 500-year flood (this is a flood having a 0.2 percent chance of occurring in any one particular year) would be reduced by about 61 percent. Some 263 existing structures subject to flooding will have full 100-year flood protection with 44 additional structures receiving partial protection. Average annual tangible benefits divided by average annual costs yield a benefit-to-cost ratio of 1.7 to 1, based on 8-1/8 percent interest and October 1983 price levels.

The Recommended Plan of improvements is estimated to cost $25,900,000 based on October 1983 price levels. Under existing laws and cost sharing procedures these costs would be shared $20,700,000 Federal and $5,200,000 non-Federal sponsor. In addition, the local sponsor would be responsible for all operation and maintenance costs currently estimated to be about $58,100 annually, plus $45,700 annual major replacement costs, totalling $103,800 annually. The Cape La Croix Creek and Walker Branch Levee and Drainage District is the local sponsor. No mitigation would be required by the implementation of the Recommended Plan and no unresolved environmental or other issues are known to exist.

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A - PROBLEM IDENTIFICATION
B - FORMULATION, ASSESSMENT AND EVALUATION OF PLANS
C - PUBLIC VIEWS AND RESPONSES (SEPARATE VOLUME)
D - HYDRAULICS AND HYDROLOGY
E - DESIGN AND COST ESTIMATES
F - ENVIRONMENTAL AND RECREATION RESOURCES
G - ECONOMICS
H - ENDANGERED SPECIES ASSESSMENT
I - CLEAN WATER ACT (SECTION 404)

CAPE GIRARDEAU-JACKSON

METROPOLITAN AREA, MISSOURI

SURVEY REPORT

VOLUME TWO

APPENDICES

CAPE GIRARDEAU-JACKSON

METROPOLITAN AREA, MISSOURI

SURVEY REPORT

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METROPOLITAN AREA, MISSOURI

SURVEY REPORT

APPENDIX A

PROBLEM IDENTIFICATION

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APPENDIX A

PROBLEM IDENTIFICATION

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PURPOSE AND AUTHORITY

1. The purpose of this appendix is to identify the authority and scope of the study, and to describe the study participants and coordination; prior studies and reports; existing and future without project conditions; and the problems, needs and opportunities identified.

PURPOSE AND AUTHORITY

2. The authority for this study stems from the following Congressional resolutions:

United States Senate

Committee on Public Works

COMMITTEE RESOLUTION

Resolved by the Committee on Public Works of the United States Senate, that the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act approved 13 June 1902, be, and is hereby requested to review the report of the Chief of Engineers on the Mississippi River between Coon Rapids Dam and the Mouth of the Ohio River, published as House Document Numbered 669, 76th Congress, and other pertinent reports, with a view to determining whether any modifications of the recommendations contained therein are advisable at this time, with particular reference to providing improvements in the interest of flood control and allied purposes, for the area along the left bank of Little River Diversion Channel, between Hubble Creek and Ramsey Branch, Cape Girardeau County, Missouri.

Adopted: 24 May 1966 /s/ ______________________

Jennings Randolph, Chairman

(At the request of Senators Stuart Symington and Edward V. Long of Missouri)

United States House of Representatives

Committee on Public Works

COMMITTEE RESOLUTION

Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors is hereby requested to review the report on the Mississippi River at Cape Girardeau, Missouri, printed in House Document Numbered 204, 81st Congress, 1st Session and other pertinent reports, with a view determining whether any modification of tl recommendations contained therein are desirable this time with respect to flood control and oth allied purposes along Cape La Croix Creek, Ca Girardeau, Missouri.

Adopted: 12 October 1972

Attest: /s/ ______________________
John A. Blatnik, M.C.
Chairman

Requested by: Hon. Bill D. Burlison

United States House of Representatives

Committee on Public Works

COMMITTEE RESOLUTION

Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors is hereby requested to review the report of the Chief of Engineers on the Mississippi River between Coon Rapids Dam and the mouth of the Ohio River, published as House Document Numbered 669, 76th Congress, 3rd Session, and other pertinent reports, with a view to determining whether any modifications of the recommendations contained therein are desirable at this time, with particular reference to providing a plan for the development, utilization, and conservation of water and related land resources of the metropolitan area, including Cape Girardeau and Jackson, Missouri. This includes, but is not limited to, Cape La Croix Creek, Hubble Creek, Indian Creek, Flora Creek, Scism Creek, Juden Creek, Sloan Creek, Ramsey Branch, Ranney Creek, and contiguous Little River Diversion Channel and Mississippi River floodplains. Such study to include, but not limited to consideration of the needs for flood control, wise use of floodplain lands, waste water management facilties, including storm water runoff, regional water supply, water quality control, recreation, fish and wildlife conservation, protection and enhancement of aesthetic qualities, and other measures for enhancement and protection of the environment in the metropolitan area. Investigation to be conducted in cooperation with the Southeast Missouri Regional Planning Commission, the state of Missouri, local government entities, and other interested federal, state, and local agencies as appropriate.

Adopted: 11 April 1974

Attest: ____________________

John a. Blatnick, M.C.

Requested by: Hon. Bill D. Burlison

SCOPE OF THE STUDY

3. Presented in the report are the findings, conclusions, and recommendations resulting from studies of water and related land resource problems for the communities of Cape Girardeau and Jackson, Missouri, which are located within the 210-square mile area described in the 11 April 1974 authorizing resolution. The entire area lies within the boundaries of Cape Girardeau County, Missouri. Initially, all reasonable solutions were considered. The most promising alternatives have been studied in greater detail. These plans are located within the Cape La Croix Creek watershed. The formulation and selection of the Recommended Plan was made after considering all factors, including those expressed by concerned agencies, the state of Missouri, the communities, and other local interests. The studies have been made in the depth and detail required to permit plan selection and to determine feasibility.

STUDY PARTICIPANTS AND COORDINATION

4. The Corps of Engineers has overall responsibility for this study.

5. Public involvement has been very important to this study. Correspondence and periodic meetings with the Cape La Croix Creek and Walker Branch Levee and Drainage District, with occasional contacts with local public officials representing the political and technical areas, were held as deemed necessary. Other agencies including the Southeast Missouri Regional Planning Commission (SEMORPC), the Department of Natural Resources (DNR), the Department of Conservation (DOC), Soil Conservation Service (SCS), National Park Service (NPS) (formerly the Heritage Conservation and Recreation Service), and Fish and Wildlife Service (USFWS) were contacted as required.

6. Citizens, elected officials, and public agencies of the Cape Girardeau-Jackson area were involved in the study in a number of ways. One way was through public/local interest meetings some of which follow:

a. a public meeting to discuss public problems/needs occurred on 3 April 1975;

b. a combined public meeting to update the public on the Stage 2 work of Cape Girardeau-Jackson and the Big Five Interior Drainage Studies on 25 January 1979;

c. a public meeting/workshop with an exchange of ideas on 8 March 1979;

d. a meeting with local interests about project status and responses to comments on 2 October 1979; and

e. a public meeting to present and discuss the array of plans on 24 February 1981.

7. Team members and the study manager met with the levee and drainage district, public officials, and the general public on numerous occasions throughout the study to discuss problems and concerns, and to receive input on pertinent portions of the work effort.

8. The SEMORPC prepared a study of the institutions which have an interest in water-related problems in the Cape Girardeau-Jackson area. The planning commission conducted an inventory of appropriate governmental agencies, public and private groups, and laws and regulations.

9. Initial inventories revealed a very complex, interrelated system of institutions. The findings of the inventory can best be explained by describing how each of the three levels of institutions, national, state and local, related to each of the following activities: (1) collection of basic data; (2) participation in the planning process; and (3) implementation of alternative plans.

10. Federal agencies which engage in the collection of water-related data in the study area include the US Geological Survey (USGS), the SCS, and the Corps of Engineers. State agencies which have collected data relevant to the study include the University of Missouri Extension Service, the Department of Consumer Affairs, the DOC, and several sections of the DNR, including the Water Quality Section. Data collection on a local level has been accomplished primarily by SEMORPC, Cape Girardeau County, the cities of Cape Girardeau and Jackson, and the Missouri Utilities Company.

11. The Federal agencies most actively participating in the Cape Girardeau-Jackson planning process include the National Park Service (NPS), the USFWS, the Corps of Engineers, the USEPA, and the SCS. The DNR is the state's chief participant in the study. In the DNR, the Division of Planning and Policy and the Division of Environmental Quality have taken the most active role. The MDC and the University of Missouri Extension Service have also actively participated. On a local level, the principal contributors to the planning process are the cities of Cape Girardeau and Jackson, Cape Girardeau County, the SEMORPC, and the Cape La Croix Creek and Walker Branch Levee and Drainage District.

12. The most important institutional considerations in the Cape Girardeau-Jackson study are those associated with implementation of the Recommended Plan. The selected plan of improvement will require a strong commitment from the Cape La Croix Creek and Walker Branch Levee and Drainage District.

13. The St. Louis District has maintained direct liaison with many government and public agencies. The most active liaison has been with the Cape La Croix Levee and Drainage District, the USEPA, NPS, USFWS, the DNR, and SEMORPC.

PRIOR STUDIES AND REPORTS

14. This section presents a summary of Federal, state, and local planning activities currently underway in the study area. Pertinent published reports are also discussed.

15. The Corps of Engineers has prepared several reports which cover certain parts of the study area. A Floodplain Information Report for the Mississippi River and Cape La Croix Creek was published in December 1969. A Corps report describing the city of Cape Girardeau flood protection project was published by the House of Representatives in June 1949. This report, the Mississippi River at Cape Girardeau, Missouri, is especially significant because, in it the Chief of Engineers and the Board of Engineers of Rivers and Harbors recommend Congressional authorization of a four-reach flood protection project for the city. Congress authorized the total project in the Flood Control Act of 1950. Reach 2, which protects an area in the downtown business district, was constructed in the 1950's. Reaches 1, 3, and 4 were placed in a deferred construction status, pending economic justification and the required local interest and cooperation.

16. SEMORPC has published a series of reports, including an inventory and evaluation of economic resources in its seven-county region; a survey of housing; a study of assessed valuation, land indebtedness and tax rates; an analysis of industrial developments; a regional economic development plan; a directory of manufacturing and basic industries; an outdoor recreation and open space plan; a report on the 1973 Mississippi River flood; and a report of the geology of the Cape Girardeau-Jackson urbanizing area. The planning commission is presently conducting studies of present and projected land uses for the City of Cape Girardeau and its immediate vicinity.

17. Under contract with the Corps of Engineers, SEMORPC prepared a report on the existing institutional system that relates to water resources in the Cape Girardeau-Jackson area.

18. In 1978, Atlantics Aerial Surveys Inc., Huntsville, Alabama, prepared 2-foot contour maps for flood control areas in the urban and urbanizing parts of the study area render a contract with the Corps of Engineers. The contours are displayed on our aerial photo base at a scale of 1 inch to 200 feet. This survey information has been very valuable for the hydrologic and hydraulic studies needed to define and display floods with various frequencies and to examine alternative solutions to flood problems. The survey information has also been used in economic and other evaluations of the alternatives.

19. Flood Insurance Studies have been completed for the City of Jackson and for the City of Cape Girardeau. The USGS made the technical studies for Jackson, Missouri while the St. Louis District, Corps of Engineers made the technical studies for the Cape Girardeau Flood Insurance Study.

20. The Missouri Geological Survey and the USGS selected the Cape Girardeau area as a test region for the development and evaluation of various resources inventory techniques termed RALI (resources and land inventory). The test region is the area covered by the Cape Girardeau USGS 7-1/2' Quadrangle. It includes the City of Cape Girardeau and its immediate environs. The remote sensing and field data assembled during the RALI study deal primarily with the engineering geology properties of the area.

21. The SCS made a soil survey of Cape Girardeau and Scott Counties, the latter borders Cape Girardeau on the south. Surveys have been completed and soils maps prepared for the entire study area. The Corps of Engineers has also obtained black and white aerial photographs from the Department of Agriculture for Cape Girardeau County.

22. Baseline water quality studies were made for eight streams in the in the winter and spring of 1975. The baseline water quality studies and comparison were accomplished through a contract with Southeast Missouri State University in Cape Girardeau. The scope of work for this contract was developed by the Corps of Engineers with the assistance of the USEPA and the DNR.

23. A wastewater management study was completed in the Cape Girardeau-Jackson area as part of the 201 facility plan for Cape Girardeau and for Jackson, Missouri. This study was made in compliance with the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500).

24. In 1977, under contract from the St. Louis District, Midwest Aquatic Enterprises of Mahomet, Illinois, prepared a report, "Biological Inventory - Cape La Croix Creek Watershed, Cape Girardeau County, Missouri." This report was the end product of an eight-week survey of the biological elements of the Cape La Croix Creek watershed.

This document provides useful information for analyzing and understanding the short-term and long-term local and regional impacts which may result from water resource development.

25. In the previous iterations of this study, the USFWS has prepared and submitted various planning reports (i.e., February 1979, March 1982, September 1982) which aided the St. Louis District in executing this study.

THE REPORT AND STUDY PROCESS

26. In order to facilitate the presentation and reference, this report has been arranged into: (1) a Main Report (Volume One); (2) Technical Appendices (Volume Two); (3) Plates (Volume Three) and (4) Public Views and Responses (Volume Four). The main report is a brief non-technical summary of the Cape Girardeau-Jackson study. It is a basic document presenting a broad overview of the study to date for the benefit of general and technical readers. The main report includes a description of the study area, including existing and alternative future problems and needs within the Cape La Croix Creek watershed; the plan formulation process; and a summary economics of the project, including the benefits, costs, and justifications.

27. The technical appendices address the same topics as the main report, except that the technical appendices cover important study activities in greater detail for the technical reviewer. Volume four contain public views and responses to the report, the environmental assessment and fish and wildlife responses.

28. The multi-objective planning framework as described in the Engineer Regulations ER 1105-2-20 and ER 1105-2-30 provided the guidance for conducting feasibility studies for water and related land resources consistent with the planning requirements of the WRC Principles and Guidelines (P&G), the National Environmental Policy Act of 1969 (NEPA), and related policies. The above regulations establish a methodology under which alternative plans as used in this study are formulated and the resulting economic, social, and environmental impacts are assessed and evaluated.

29. The P&G require that Federal water and related land planning be directed to achieve National Economic Development (NED) consistant with protecting the Nations environment, pursuant to National environmental statutes, applicable executive orders, and other Federal planning requirements. NED is to be achieved by increasing the value of the nation's output of goods and services or to increase national economic efficiency. This is achieved by reducing flood losses in the Cape La Croix Creek watershed and increasing the recreation experience within the study area. The P&G also require that the impact of a proposed action be displayed and accounted for in terms of contributions to four accounts. These four accounts are: (1) National Economic Development; (2) Environmental Quality; (3) Regional Economic Development; and (4) Social Well-Being.

30. To accomplish the goals and objectives of the multi-objective planning framework, the study process was divided into three sequential stages. These are: (1) Reconnaissance; (2) Development of Intermediate Plans: and (3) Development of Detailed Plans. Within each of these three

stages, four planning tasks were carried out. The planning tasks are: (1) Problem Identification; (2) Formulation of Alternatives; (3) Impact Assessment; and (4) Evaluation. It should be noted that while each of the four tasks were carried out in each stage, a different emphasis is placed on each task in each stage. For instance, during Stage 1 the major emphasis was on Problem Identification (Task 1). Some effort was devoted to the formulation of alternatives and impact assessment, and evaluation, but the major endeavor dealt with Task 1. During Stage 2, the major emphasis was on formulation of alternatives, impact assessment, and evaluation. During Stage 3, Development of Detailed Plans, the alternatives carried forward from Stage 2 were further refined, reanalyzed, and reformulated. Emphasis at this 3rd stage was placed on impact assessment and evaluation leading toward plan selection and recommendations leading to the selection of the Recommended Plan.

NATIONAL OBJECTIVES

31. This study initially followed the guidance as presented in the Water Resource Council's Principles and Standards (P&S). The P&S require that, whenever possible, candidate plans include at least one EQ plan and one NED plan and one NS (Nonstructural) plan. On March 10, 1983, new and revised guidelines (P&G) were issued.

32. The P&G recommends that all impacts of proposed action be measured and the results displayed in terms of their contributions to: National Economic Development (NED), Environmental Quality (EQ), Regional Development (RD), and Social Well-Being (SWB). The NED served as a basis for the Recommended Plan. The NED Plan provided for the greatest benefits for each dollar expended. The NED and EQ accounts have already been discussed. Contributions to the RD accounts are determined by establishing a proposal's effects on the region's income, employment, population, economic base, environment, and social development. Contributions to the SWB account are determined by establishing a proposal's effects on the real income, security of life, health and safety, education, cultural and recreational opportunities, emergency preparedness, and other factors within the subject region.

STUDY AREA PROFILE

33. In order to establish a frame of reference for subsequent discussions, the following presents information about the environmental, natural, and human resources of the study area as well as details about its development and economy. The information was obtained through literature searches, data research contracts, and Corps of Engineers' observations within the watershed. All known sources of information are cited where appropriate and are on file in the offices of the St. Louis District, Corps of Engineers.

34. Overview. The study area encompasses 210 square miles of rural, urban, and urbanizing lands, all lying within Cape Girardeau County in southeast Missouri. The boundaries of the study area (see PLATE A-1) were determined with the assistance of the Southeast Missouri Regional Planning Commission (SEMORPC). The SEMORPC has designated a part of the study area as the "Cape Girardeau-Jackson Urban Complex." This is the major growth center in the Commission's seven-county planning region (see PLATE A-2).

35. The western and northern boundaries of the study area were determined based on present and projected growth patterns of the cities of Cape Girardeau and Jackson. Interstate 55 lies between Cape Girardeau and Jackson. It divides the study area approximately in half. The general trend of growth of Cape Girardeau and Jackson is toward Interstate 55, and toward one another. One exception to this trend is a large industrial plant located in the northern part of the study area. The northern and western borders of the study area are formed by the drainage divides of the Indian and Hubble Creeks' watersheds.

36. Two major watercourses, the Mississippi River and the Little River Diversion Channel, form the eastern and southern boundaries of the study area. The agricultural lands lie immediately south of the study area. However, the Cape Girardeau municipal airport, an industrial park, and two towns, Scott City and Illmo, Missouri, are in close proximity to the study area's southern boundary. A potential for urban expansion exists in this general location. The area to the west of the city of Jackson is also expected to develop and may eventually be annexed by this municipality. There are no indications that other lands bordering the Cape Girardeau-Jackson study area will undergo significant urban-type developments in the near future.

37. Small streams drain most of the land in the study area. These streams are Cape La Croix Creek, Ramsey Branch, Ranney Creek, Hubble Creek, Indian Creek, Flora Creek, Scism Creek, Juden Creek, and Sloan Creek. Cape La Croix Creek is the major urban stream. Approximately 75 percent of its 21.4 square mile watershed is located in the City of Cape Girardeau. Juden Creek and Ramsey Branch are partially urbanized as a result of the expansion of Cape Girardeau. The only other watershed with significant urban development at this time is Hubble Creek. The town of Jackson lies in the upper reaches of this stream. TABLE A-1 presents additional information of these watersheds and their attendant water-related problems and opportunities.

TABLE A-1
DESCRIPTION OF STUDY AREA BY WATERSHED

Stream	Approximate Watershed Drainage Area (sq mi)	Existing Land Use	Area Problems	Area Opportunities	Area Projection
MAJOR					
Cape La Croix & tributaries	22	25% urban 75% rural	flooding stream bank erosion water quality* wastewater* management	(1) floodplain management recreation environmental and scenic preservation and enhancement	Cape Girardeau - 35,000, prosperous city, rapidly expanding in industry and population
Hubble Creek & tributaries	85	10% urban 90% rural	flooding stream bank erosion water quality* wastewater managment*	(1)	Jackson - 6,500, progressive expanding city. Eventually will be contiguous with Cape Girardeau Gordonville - 200, experiencing growth
Indian Creek & tributaries	40	5% urban 95% rural	flooding minor stream bank erosion future water quality future wastewater management	(1)	New Charmin plan presently expanding. Trail of Tears State Park regional recreation area. Some existing residential development, more projected.
Flora Creek & tributaries	30	100% rural	minor flooding minor stream bank erosion	(2) floodplain management environmental and scenic preservation and enhancement	Some residential development projected.

*Problems are being addressed in Section 201 facilities planning and construction program.

TABLE A-1 (Continued)

Stream	Approximate Watershed Drainage Area (sq mi)	Existing Land Use	Area Problems	Area Opportunities	Area Projection
MINOR					
Scism Creek	7	100% rural	minor flooding minor stream bank erosion	(2)	Some residential development projected.
Juden Creek	6	20% urban 80% rural	minor flooding minor stream bank erosion water quality* wastewater management*	(1)	Some residential development projected.
Sloan Creek	3	50% urban 50% rural	flooding stream bank water quality* wastewater management*	(1)	Cape Girardeau expansion to the north, extensive residential development projected.
Ramsey Branch	12	10% urban 90% rural	flooding minor stream bank erosion future water quality future wastewater management	(1)	Cape Girardeau residential expansion to the west and industrial expansion to the south projected.
Ranney Creek	5	100% rural	minor flooding minor stream bank erosion	(2)	Not established.
Total Area	210				

*Problems are being addressed in Section 201 facilities planning and construction program.

38. The study area also includes portions of the floodplains of the Little River Diversion Channel and the Mississippi River. A one to two mile wide floodplain lies to the north of the Little River Diversion Channel. This large man-made channel drains a large region to the west of the study area by diverting the Castor and Whitewater Rivers to the Mississippi River. It is sometimes called the Headwater Channel. To be consistent, it will be referred to as Little River Diversion Channel throughout this study. North and south of Cape Girardeau unprotected floodplain areas lie along the Mississippi River on the right bank.

LAND RESOURCES

39. The land resources are discussed under the topics of geology and soils.

40. Geology. The Cape Girardeau-Jackson study area lies in two physiographic regions, the Salem Plateau (Ozark Uplands) and the Mississippi Alluvial Plain (Southern Lowlands), thus producing two topographical types. The area also lies on the eastern flank of the Ozark Dome, causing the geology to vary from west to east.

41. The most rugged terrain, the Cape Hills, are located in the northeast portion of the study area. The western and central portions are referred to as the Central Rolling Hills, and the southern and eastern borders are part of the Mississippi Alluvial Plain. The greatest local relief is found along the major tributaries that have cut through resistant limestone/dolostone. The Cape Hills have slopes of over 15 percent, which is generally recognized to have severe limitations for general urban use. The Central Rolling Hills' slopes range from 5 to 15 percent. The Mississippi Alluvial Plain is considered to be a gently rolling plain with a surface relief of less than a few feet.

42. The bedrock ranges in age from Middle Ordovician on the west flank to Devonian on the east side. The bedrock in the west consists of the Everton Formation, a light to dark gray dolostone with interspersed beds of sandstone; the St. Peter Formation, a well-sorted quartzose sandstone; the Dutchtown Formation, a thin-bedded blue, gray or black limestone/dolostone; and the Joachim Formation - an argillaceous, yellowish-brown dolostone. The Plattin Formation consisting of fine to microcrystalline, a dark gray, limestones and the Kimmswick Formation with its coarsely crystalline white to light gray limestone are found in the west central section. These formations tend to be highly jointed, pitted, permeable, and often karstic. They underlie most of the Central Rolling Hills. The Decorah, a green to brown shale with interbedded limestone, can often be found between these two formations. The bedrock in the east central section, including the city of Cape Girardeau, is composed of the Cape Formation, a gray, argillaceous, fossiliferous, coarsely crystalline limestone; the Marquoketa Formation, a green to brown, thinly laminated shale with local limestone nodules; the Thebes Formation, a gray to bluish-gray, fine grained sandstone that weathers to

a yellowish-brown; the Girardeau Formation, a microcrystalline, dark to medium gray limestone with blue and brown chert nodules. The Sexton Creek Formation, an olive gray, fine to medium crystalline limestone with interbedding chert; the Bainbridge Formation, a dark red, argillaceous limestone; and the Baily Formation, a tan limestone with chert beds are found in the northeast section. Many places in the uplands region, a mantle of Pleistocene loess overlies the bedrock. In the Mississippi Alluvial Plain, bedrock is covered by recent deposited alluvium, ranging in thickness from three to over sixty feet.

43. The Region is located within the Western Embayment and the Ozark Random Seismic Zones. Both zones have moderate seismic activity, hense small tremors may occur and a potential for a major earthquake is present. The area is also very close to the very active seismic New Madrid Zone. Therefore, a major earthquake in this region would cause considerable damage in the study area. There are several minor faults, and the Jackson fault. The major fault runs from the Mississippi River through Jackson. None of these faults are considered active. Brooks Dome in which the Kimmswick Formation outcrops in the center, is another structural feature. It is located northeast of Cape Girardeau. Oil tests in this Domed area were negative.

44. Soils. The US Soil Conservation Service in cooperation with the Missouri Agricultural Experiment Station recently published a soils survey for Cape Girardeau County. This survey includes a description of the engineering, agricultural, and other properties of the soil units. The Menfro-Clarksville Association is dominant in the Cape Hills area. This association is primarily used for woodland and pasture. It produces good wildlife habitats, if properly managed. The Menfro Association covers the central rolling hills area. This soil consists of a deep, well-drained silt loam. This soil is used for pasture, hay, row crops, small grains, and woodlands on the steeper slopes. The Haymond-Wakeland Association is also an important soil type. This association includes deep, somewhat poorly-drained to well-drained soils that have formed in nearly level, silty alluvium of the major floodplain areas. Soils of this association are good for the production of all crops grown in the region. The fertility and water capacity of this soil is quite high. A specific soil association that would meet the requirements for prime farmland are Menfro, Wakeland, and Haymond silt loams. However, in certain areas of the watershed, these soils, due to the frequency of floods more than once every two years, and the topography, could not be classified as prime farmland.

45. Due to flooding, the Haymond-Wakeland Association has severe limitations for most urban uses. The upland types, the Menfro-Clarksville and the Menfro Associations have slight to moderate urban usage limitations on slopes less than 15 percent and severe limitations on slopes more than 15 percent.

46. If a Corps of Engineers project would be implemented, the most suitable construction material would be soils found on the ridge tops and hillsides. This material, along with soil modification techniques such as compaction and drying, would eliminate soils as a potential constraint for construction.

AIR RESOURCES

47. The air resources are discussed under the topics of air quality, noise, and climate.

48. Air Quality. Conversations with Mr. Langston of the Kansas City office of the USEPA and Mr. Raymond of the DNR indicate that the air quality of the study area is presently attaining Federal and state air quality standards. This condition will also be met in the foreseeable future.

49. Noise. Noise levels are generally within the recommended limits established by the USEPA (personal communication with Mr. Tyler of the Kansas City office). Neither the USEPA nor the state of Missouri presently have the authority to enforce noise standards. Regulation of noise complaints is primarily handled at the local level.

50. Climate. The region's average monthly temperatures range from 31°F. in January to 79°F. in July, although extremes of below zero and over 100°F. occur. The mean annual precipitation for Cape Girardeau is 45 inches. The most recent storm of unusual intensity, was on 30 May 1973 when 9.71 inches of rain fell in 8 hours. This storm caused considerable flash flooding and damages along Cape La Croix Creek and Walker Branch.

WATER RESOURCES

51. The water resources are discussed under the topics of wastewater management, water quality, and water supply.

52. Wastewater Management. Based on a water quality investigation conducted by Southeast Missouri State University in the spring of 1975, point pollution sources are judged to have adverse effects on the quality in some of the streams. Organic and suspended materials discharged by the Jackson sewage treatment plant into Hubble Creek, and the combined sewer overflow discharge from the Henderson Avenue grit removal and lift station in Cape Girardeau, periodically result in additional pollution loads in the lower reaches of Cape La Croix Creek. See APPENDIX F for a summary of pertinent sampling data. Sewage lagoons from outlying residential and commercial developments adversely affect the water quality in the Hubble, Cape La Croix, and Juden Creeks. They are expected to cause future problems in Indian Creek.

53. State and local facilities planning to improve point pollution control is underway. Section 201 of the Water Pollution Control Act Amendments of 1972 (PL92-500) provides Federal grants for facilities planning and construction. The DNR has designated separate facilities planning areas for Cape Girardeau and Jackson. The aims of the Section 201 planning are threefold: (1) to upgrade municipal treatment plants; (2) to reduce the number of the small separate treatment facilities by tying them into municipal collection systems; and (3) to upgrade those separate treatment facilities that cannot economically be incorporated into municipal systems.

54. Facility plans have been prepared for Cape Girardeau and Jackson. Cape Girardeau's plan calls for minor wastewater collection system improvements and major sewage treatment plant improvements. Jackson's 201 Wastewater Facilities Plan calls for an improved and enlarged sewage treatment plant, an expanded collection system, and infiltration/inflow repairs.

55. The Cape Girardeau-Jackson area's non-point pollution problems are considered to be similar to those in many small cities and agricultural areas in Missouri. Storm water runoff from the urban surroundings of Cape Girardeau carries polluting materials into Cape La Croix, Sloan, and Juden Creeks. Runoff from the Jackson area is believed to adversely affect the water quality in Hubble and Goose Creeks. In view of the projected expansion of Cape Girardeau and Jackson, future urban storm runoff pollution problems are expected in Ramsey Branch, Williams and Randolf Creeks. Non-point source pollution from storm runoff from agricultural activities and rural developments have been indicated by field surveys and water samplings. Row crops and livestock husbandry are the principal sources of agriculturally based pollution. Septic tank malfunctions, direct house-to-stream sewage, and farm lot runoff are the principal sources of rural pollutants.

56. Section 208 of PL 92-500 requires that areawide point and non-point pollution problems be addressed. USEPA and DNR do not consider Cape Girardeau-Jackson's areawide and non-point pollution problems sufficiently serious to merit the area's designation as a "208 area." Since the study area has not been designated as a "208 area," the state of Missouri is responsible for making the areawide water management studies required under Section 208.

57. Water Quality. Although improved water quality is obviously related to improved wastewater management facilities, water quality can also be affected by other programs, e.g., stream bank erosion control and green belts along streams. For this reason, wastewater management and water quality are treated separately in the Cape Girardeau-Jackson study.

58. In general, point and non-point pollution sources contribute to water quality problems. However, the Missouri Clean Water Commission has classified all streams in the study area as effluent limited. In an

effluent limited stream water quality does or is expected to meet applicable water quality criteria after the application of a required base level of treatment. This base level of treatment is defined as the best practicable control technology currently available for industrial point sources.

59. The water quality of local streams is not expected to impair the groundwater resource. The Missouri Geological Survey does not consider the study streams will pollute groundwater resources. Pollution from septic tank seepage, petroleum, chemicals, and fertilizer is expected to increase and will create an adverse impacts. This problem may ultimately lead to the degradation of the city's water supply.

60. Water Supply. The Missouri Utilities Company are owners of the city of Cape Girardeau's water supply and distribution system in Cape Girardeau. The Mississippi River is the major water supply source for the Cape Girardeau system. The company's water treatment plant on the Mississippi River has a capacity of 4.5 mgd. Missouri Utilities also owns and operates three wells. One of these wells is connected to the supply system to provide water to an area that is not served by the water treatment plant. The other two wells provide untreated water to an industrial tract just south of the Little River Diversion Channel.

61. The water supply system is adequate for existing needs. However, a major expansion and improvement program will have to be implemented if the city's projected water demands are to be met. Missouri Utilities Company intends to expand its facilities, as needed, to meet future water supply demands. As the city expands to the west, deep wells are expected to be developed to supplement existing supplies.

62. Three city-owned wells with a combined capacity of 1,800 gpm. or about 2.59 mgd. supply potable water to the city of Jackson. In addition to expanding well capacities, the city has also recently improved its well-water treatment plant and its storage facilities. Jackson has an adequate water supply for the near future. The city intends to expand and improve its water supply system as demand increases.

63. Public water supply districts serve the towns of Fruitland and Gordonville. These small communities are expected to expand and thus the demands for water will grow in the future. Other small towns and rural residents in the study area rely on individual wells or cisterns for their water. One potential water supply problem in the rural locations is that surface pollutants and septic tank leaks gas or other pollution sources which may contaminate individual supplies. According to the Cape Girardeau sanitation department few incidences of such problems have been reported in the last decade.

CULTURAL RESOURCES

64. In 1977, under contract from the St. Louis District, the University of Missouri conducted a cultural resource survey of the Cape Girardeau-Jackson region. The survey consisted of an on-foot reconnaissance of 680 acres along Cape La Croix, Hubble, and Goose Creeks. A total of twenty archaeological and historical sites were discovered in the field and through documentary research. These sites ranged in age from 5,000 to 1,000 years old and included archaic Woodland and Mississippian remnants in addition to early pioneer cabin sites, and 19th century structures.

65. During this 1977 survey, Cape La Croix Creek was surveyed upstream approximately 27,000 feet from its confluence with the Mississippi River. This survey covered the majority of an area 300 feet wide on both sides of the stream, totaling approximately 360 acres. Within this area eleven archaeological sites were identified. These locations included nine prehistoric and two historic sites. A team from Southern Illinois University-Edwardsville surveyed an additional 120 acres in 1982, because the size of the project was increased in Stage 2 of the study. This second survey resulted in that four prehistoric sites and one historic site were located in addition to the previously identified locations.

BIOLOGICAL RESOURCES

66. Shortly after the study was initiated economic and hydrological data showed that the investigation would focus on the Cape La Croix Creek watershed. Hence, and because of funding constraints, it was decided to concentrate on the Cape La Croix watershed in collecting information dealing with biological resources. Under a contract with Midwest Aquatic Engerprises an inventory of the watershed was prepared in 1977. Details of this endeavor are presented in APPENDIX F.

AQUATIC COMMUNITIES

67. The watershed of Cape La Croix Creek and its tributaries is classified as Ozark Upland except for the lower portion which is classified as Southeastern Lowland. Approximately 25 percent of this watershed is urbanized.

68. The Ozark Upland portion of the creek, which has a bedrock/cobble/gravel bottom, has a greater gradient than the Southeastern Lowland portion. Primarily attached algae (periphyton) compose the flora of this stream segment. Zooplankton thrives in pool areas but is low in other parts. Mayflies and midges are abundant. Stonerollers, creek chubs, and black spotted top minnows are the major fish species.

69. In the Southeastern Lowland part of Cape La Croix Creek and its tributaries urban land uses dominate. This part of the stream has primarily a mud bottom, much of this creek segment has levee channelized. It includes most of the creek in town and downstream to its confluence with the Mississippi River. Its value for fish and wildlife pruposes is negligible. Various minnows, red shiners, red fin shiners, common suckers, spotted suckers and black bullheads are found in unchannelized sections. When the Mississippi River is high and water backs up into Cape La Croix Creek other fish species common to the Mississippi River may then be found in the creek.

70. Walker Creek, a tributary to Cape La Croix, is entirely urban. Part of this creek has been channelized, and few fish and wildlife habitats exist in or along the creek.

TERRESTRIAL COMMUNITIES

71. A 30-acre wooded swamp located near the US Highway 61/Missouri Highway 74 junction is a very unique and valuable wildlife area, because it is a relic of vegetation once covering much of the Southeastern Lowlands.

72. This area is now threatened by extinction as development expands in a southeasterly direction from the above highway junction. Parts of the swamp's periphery are lost each year as more and more fill materials are dumped into it. A wide variety of plant species is found in this swamp. Black willow is the predominant tree species, while ash, red maple, and silver maple are also found, albeit in far fewer numbers. Most of the ash and maple trees are dead. Swamp rose, buttonbush, and black willow are the main understory species found, with arrow arum and lizard's-tail comprising the majority of the ground cover. Duckweed covers the water surface. The water depth in the wooded swamp varies from just saturating the soil to a depth of about three feet.

73. Box elder, ash, and American elm dominate the bottomland hardwood forest. Ground cover is primarily bindweed, poison ivy, marsh fleabane, wild onion, and Japanese honeysuckle. Bottomland hardwood forest is limited in the watershed because of the narrow floodplain of the creeks and farming activities in the floodplain.

74. Upland hardwood forests comprise approximately 21.4 percent of the Cape La Croix creek watershed. These habitats are located mainly in the headwater area, and secondarily in the lowlands area south of the city of Cape Girardeau.

75. The upland hardwood forest is typically an oak-hickory-elm complex. Tree species include: shagbark hickory, pignut, mockernut, white oak, rock chestnut, red oak, black oak, shingle oak, American elm, slippery elm, winged elm, tulip tree, sweetgum, white ash, hackberry, and sugar maple. The ground cover is composed primarily of bloodroot, may apples, green dragon, Virginia creeper, and poison ivy.

76. Old fields exist primarily in areas which are being converted to urban land uses. Plant species include primarily annuals such as ragweed, milkweeds, asters, fleabanes, and poison ivy. These old fields provide only temporary habitat for wildlife.

77. Corn, sorghum, soybeans, and wheat are the main crops. These crops provide food and edge habitats for wildlife.

78. Pastures are planted with fescue, bluegrass, or numerous other grasses. Pasture management practices, such as time of year and duration and density of grazing, affect the variety and amount of forbs and brush present. These plants supply food and cover for wildlife.

79. Urban areas generally contain few wildlife habitats. The habitat values vary according to the density and type of trees and shrubs.

80. The Midwest Aquatic Enterprises Biological Inventory, Cape La Croix Creek Watershed, Cape Girardeau, Missouri (January, 1977) has a comprehensive list in the study area's wildlife; this report also contains detailed habitat descriptions. Typical animals in the watershed are white-tailed deer, cottontail rabbits, muskrats, beavers, fox and gray squirrels, ground hogs, raccoons, striped skunks, opossums, bats, vireos, flycatchers, house wrens, screech owls, barred owls, red-bellied woodpeckers, common flickers, warblers, Carolina chickadees, tufted titmice, brown-headed cowbirds, sparrows, cardinals, morning doves, crows, blue jays, American Kestrels, killdeers, night hawks, turkey vultures, chimney swifts, marsh hawks, red-tailed hawks, various rodents, and numerous amphibians and reptiles. These species vary in abundance according to the type and conditions of the habitats.

PESTIFEROUS PLANTS AND ANIMALS

81. Among the pestiferous plants and animals known or thought to occur in the Cape La Croix Creek watershed are several plants, numerous invertebrate species or groups, two mammals, and representatives of two families of snakes.

82. Skin irritation from poison ivy, allergic reactions to the pollen of ragweeds, and irritation caused by the hairs of stinging nettle may discomfort people.

83. Problems caused by invertebrate pests include bites from brown recluse and black widow spiders and diseases transmitted by the lonestar tick and woodtick. Flies that bite include biting midges, black flies, mosquitoes, deer flies, and robberflies. Mosquitoes are potentially harmful to humans and livestock through their transmittal of viruses that produce encephalitis.

84. Honey bees, bumblebees, yellow jackets, hornets, paper wasps, and mud daubers can produce painful bites and/or stings. The striped skunk and the spotted skunk are obvious pests to humans and animals because of their defensive, offensive spraying. Five venomous snakes occur in the watershed. While they can inflict bites which are potentially fatal to man, these snakes are very secretive and are hardly ever seen. They include the northern copperhead, the southern copperhead, timber rattlesnake, the western cottonmouth, and the canebrake rattlesnake.

THREATENED, RARE, AND ENDANGERED SPECIES

85. Two Federally listed endangered species, the bald eagle and peregrine falcon, can occasionally occur in the region. Based on available information, neither of these two species, nor any other Federally listed endangered or threatened species, are known to have critical habitat within the watershed.

HUMAN RESOURCES

86. Human resources are described under the topics of population trends, and projections, and employment by occupation.

87. Population Trends and Projections. Population statistics serve as indicators of regional economic and social well-being. The growth of population, as illustrated in TABLE A-2, has steadily increased over the past fifty years. From 1930 to 1980, growth has been accelerating. Even during the recessions of the 1950's, emigration did not manifest itself in the volume of increases in population as witnessed by the 9.4 percent rise in the number of county residents during the decade.

88. Cape Girardeau's growth is a product of numerous factors, such as:

a. Good agricultural lands and suitable topography;

b. Surface, water, air and rail transportation facilities;

c. The development of commercial establishments which offer a wide variety of products and services and serve as a regional shopping area;

d. The continued expansion and broadening of the curriculum and the student body at Southeast Missouri State University;

e. The development of medical facilities and the location of specialists serving a large area in Missouri and Illinois;

f. Continued expansion of the industrial base and warehousing facilities; and

g. Geographic location with regard to major industrial centers, transportation, and recreation.

89. Cape Girardeau County's future in all probability will include continued population growth, as is reflected in the population projections. The basis for this assumption is the region's stable industrial mix.

TABLE A-2
POPULATION TRENDS: CAPE GIRARDEAU-JACKSON

YEAR	CAPE GIRARDEAU COUNTY (% CHANGE)	CAPE GIRARDEAU CITY (% CHANGE)	CITY OF JACKSON (% CHANGE)	MISSOURI
1930	33,203	16,227	2,465	3,629,367
1940	37,775 (13.8)	19,426 (19.1)	3,113 (26.3)	3,784,664 (4.3)
1950	38.397 (1.6)	21,578 (11.1)	3,707 (16.0)	3,954,653 (4.5)
1960	42,020 (9.4)	24,947 (15.6)	4,875 (31.5)	4,319,813 (9.2)
1970	49,350 (17.4)	31,282 (25.4)	5,896 (20.9)	4,677,623 (8.3)
1980	58,837 (19.2)	34,361 (9.8)	7,827 (32.8)	4,916,759 (5.1)

SOURCE: US Bureau of the Census, Census of Population and Housing, 1980.

90. Projections. The technique used for predicting the future population of the Cape Girardeau-Jackson study area incorporated OBERS data (as required by ER 1105-2-200) with a log-log transformation of a polynomial curve fit program. This technical analysis is documented and on file in the St. Louis District office. TABLE A-3 shows the resulting population projections.

TABLE A-3
POPULATION PROJECTIONS
CAPE GIRARDEAU COUNTY

		SEMO [1]			
	Low	Median	High	This Report	Actual
1980	54,830	57,309	59,220	61,200	58,837
1990	60,310	66,014	71,064	67,200	-
2000	65,790	75,597	85,277	75,600	-

[1] a. Low projection based on average rate of increase of 2,740 persons per 5 years between 1950 and 1970.

b. Median projection based on the average between increases calculated from the number increase between 1960 and 1970 (3,605 per decade) and the percentage increase between 1960 and 1970 (17.4 percent).

c. High projection based on assumed rate of increase of 20 percent per decade.

91. TABLE A-3a shows the population increasing at a decreasing rate using a log-log transformation of a poly-curve fit. Numbers are rounded to the nearest 100.

TABLE A-3a
LOG-LOG TRANSFORMATION OF A POLY-CURVE FIT 3/

Year	(1) Cape Girardeau County	(2) Cape Girardeau City	(3) Jackson	(4) RSA 1/	(5) Hinterland 2/
1950	38,400	21,600	3,700	5,200	7,900
1960	42,000	24,900	4,900	4,900	7,300
1970	49,400	31,300	5,900	4,900	7,300
1980	61,200	42,700	8,700	3,900	5,900
1990	67,200	48,300	10,100	3,500	5,300
2000	75,600	56,400	11,900	2,900	4,400
2010	81,500	62,300	13,200	2,400	3,600
2020	88,000	68,100	14,700	2,100	3,100
2030	92,700	72,600	15,700	1,800	2,600

1/ RSA: Remaining Study Area

2/ Hinterland: Remaining County Area

3/ Columns 2, 3, and 4 from the Study Area population

92. <u>Employment by Occupation</u>. Over half of the total number of persons employed in Cape Girardeau County in 1980 were classified in one of five occupational categories: Managerial, Professional, Technical, Sales and Administrative Support. The cities of Cape Girardeau and Jackson have patterns similar to the county. The city of Cape Girardeau however, has a proportionately higher number of service workers, and Jackson has a significantly higher number of operatives, excepting transport workers. TABLE A-4 displays the pertinent national, state, county, and local employment data.

EDUCATIONAL ATTAINMENT

93. TABLE A-4a indicates the educational attainment of Cape Girardeau City and County and the state of Missouri in 1980. While Cape Girardeau County is predominantly rural, the educational attainment surpasses that of the state of Missouri. This is explained by the fact that Cape Girardeau is the location of Southeast Missouri State University.

INCOME

94. Several measures of income can be utilized to illustrate the relative levels of income in Cape Girardeau County in comparison to the state of Missouri. Specific measures of income considered include:

a. Percentage frequency distribution of family income;

b. Mean income;

c. Median income;

d. Per capita income for individuals.

e. Income below poverty level.

TABLE A-4
EMPLOYMENT BY OCCUPATION: 1980
THE UNITED STATES, CAPE GIRARDEAU COUNTY,
CAPE GIRARDEAU, MO & JACKSON, MO

Occupation	Missouri Total	Missouri %	Cape Girardeau County Total	Cape Girardeau County %	City of Cape Girardeau Total	City of Cape Girardeau %	City of Jackson Total	City of Jackson %
Employed, 16 Years Old & Older	2,103,907	100.0	26,705	100.0	15,989	100.0	3,423	100.0
Managerial and professional specialit occupations	439,989	20.9	5,851	21.9	4,041	25.3	699	20.4
Executive, Administrative,& Managerial occupations	200,819	(45.6, 9.5)	2,588	(44.2, 9.7)	1,757	(43.5, 11.0)	379	(54.2, 11.1)
Professional specialty occupations	239,170	(54.4, 11.4)	3,263	(55.8, 12.2)	2,284	(56.5, 14.3)	320	(45.8, 9.3)
Technical, sales, and administrative support occp.	632,053	30.0	8,109	30.4	5,257	32.9	1,089	31.8
Technicians and related support occupations	60,071	(9.5, 2.8)	765	(9.4, 2.9)	502	(9.6, 3.1)	134	(12.3, 3.9)
Sales occupations	214,071	(33.9, 10.2)	3,434	(42.4, 12.9)	2,231	(42.4, 14.0)	494	(45.4, 14.4)
Administrative support occupations incl. clerical	357,911	(56.6, 17.0)	3,910	(48.2, 14.6)	2,524	(48.0, 15.8)	461	(42.3, 13.5)
Service occupations	285,478	13.6	3,943	14.8	2,785	17.4	391	11.4
Private household occupations	11,158	(3.9, 0.5)	183	(4.6, 0.7)	124	(4.4, 0.8)	32	(8.2, 0.9)
Protective service occupations	28,448	(10.0, 1.4)	252	(6.4, 1.0)	166	(6.0, 1.0)	50	(12.8, 1.5)
Service occupations, except protective & household	245,872	(86.1, 11.7)	3,508	(89.0, 13.1)	2,495	(89.6, 15.6)	309	979.0, 9.0)
Farming, forestry, and fishing occupations	88,836	4.2	1,203	4.5	173	1.1	55	1.6
Precision production, craft & repair occupations	256,371	12.2	2,933	11.0	1,421	8.9	431	12.6
Operators, fabricators, & laborers	401,180	19.1	4,666	17.4	2,312	14.4	758	22.2
Machine operators, assemblers, & inspectors	199,354	(49.7, 9.5)	2,284	(49.0, 8.5)	1,056	(45.7, 6.6)	442	(58.3, 12.9)
Transportation & material moving occupations	102,619	(25.6, 4.9)	1,420	(30.4, 5.3)	714	(30.9, 4.4)	177	(23.4, 5.2)
Handlers, equipment cleaners, helpers, & laborers	99,207	(24.7, 4.7)	962	(20.6, 3.6)	542	(23.4, 3.4)	139	(18.3, 4.1)

SOURCE: US Census Bureau, Census of Population, 1980; General Social and Economic Characteristics.

TABLE A-4a
EDUCATIONAL ATTAINMENT OF POPULATION IN CAPE GIRARDEAU, MISSOURI,
CAPE GIRARDEAU COUNTY, AND STATE OF MISSOURI, 1980

Percent of Population
25 Years of Age and Older

Geographic Area	Grade Level Attained				
	0-8	9-11	12	13-15	16 or More
City of Cape Girardeau	20.8	11.5	29.9	17.3	21.0
County Cape Girardeau	24.2	12.0	33.0	13.7	17.1
State of Missouri	21.7	14.8	36.3	13.3	13.9

Source: Census of Population, General Social and Economic Characteristics, 1980

95. Dollar figures are reported in 1967 constant dollars unless otherwise stated. This eliminates any inflationary bias and facilitates comparison of dollar values over time.

96. These figures very closely resemble poverty figures for the state of Missouri in 1969, in which 11.5 percent of all families reported poverty level incomes while 7.3 percent reported income of less than 75 percent of the poverty level.

INDUSTRIAL MIX AND ECONOMIC STABILITY

97. The distribution of employment between the various economic sectors in Cape Girardeau County has shifted from traditional rural occupations to urban employment activities. As indicated in TABLE A-5, manufacturing, wholesale and retail trade, and services together provided approximately 75 percent of the total county employment in 1980, up 3 percent since 1970. Agriculture, forestry and related industries declined 2 percent since 1970 and 7 percent since 1960. TABLE A-5 also presents statistics that indicate the relative diversity of the study area in terms of industrial mix. The Cape Girardeau-Jackson urban complex employs 73 percent of total county employment. Most of the county's industrial activity is located in the study area's manufacturing network. Total county employment is 26,705 and there are about 19,412 workers in the Cape Girardeau-Jackson urban complex.

98. The location quotient shown in Figure TABLE A-5 is a factor analytic tool which provides a reasonably accurate device by which industrial mix and economic stability can be evaluated. The location quotient (LQ) is found by taking the ratio of the percentage employed locally in industry "i" to the percentage employed statewide in that same industry. It is an index measure of the degree of specialization. An LQ value of 1.00 indicates that the locality in question specializes in a particular industry to the same degree that it is observed across the state. An LQ less than 1.00 indicates that the area specializes to a lesser extent in a particular industry than does the state, and vice versa.

TABLE A-5
EMPLOYMENT BY INDUSTRY

	Missouri		Cape Girardeau County			City of Cape Girardeau			City of Jackson		
	Total	%	Total	%	LQ	Total	%	LQ	Total	%	LQ
EMPLOYED PERSONS 16 YEARS AND OVER	2,103,907	100.0	26,705	100.0		15,989	100.0		3,423	100.0	
Agriculture, forestry & fisheries	89,685	4.3	1,283	4.8	1.12	185	1.2	.18	78	2.3	.53
Mining	9,686	0.5	64	0.2	.40	33	0.2	.40	12	0.4	.80
Construction	118,437	5.6	1,632	6.1	1.09	741	4.6	.75	277	8.1	1.45
Manufacturing	461,662	21.9	4,909	18.4	.84	2,409	15.1	.69	815	23.8	1.09
Nondurable goods	193,125	(41.2, 9.2)	3,298	(67.2) (12.4)	1.35	1,642	(68.2) (10.3)	1.12	500	(61.4) (14.6)	1.59
Durable goods	268,537	(58.2, 12.7)	1,611	(32.8) (6.0)	.47	767	(31.8) (4.8)	.38	315	(38.6) (9.2)	.72
Transportaton, communications, & other public utilities	172,514	8.2	1,777	6.7	.82	1,080	6.7	.82	232	6.8	.83
Wholesale and retail trade	446,351	21.2	6,381	23.9	1.13	4,141	25.9	1.22	810	23.7	1.12
Finance, insurance, and real estate	114,718	5.5	1,202	4.5	.82	819	5.1	.93	189	5.5	1.00
Business & Repair services	79,876	3.8	835	3.1	.82	511	3.2	.84	105	3.1	.82
Personal Services	67,688	3.2	885	3.3	1.03	585	3.7	1.16	97	2.8	.88
Entertainment & recreation services	17,433	0.8	236	0.9	1.13	192	1.2	1.50	32	0.9	1.13
Professional & releated services	424,848	20.2	6,685	25.0	1.24	4,786	29.9	1.48	676	19.7	.98
Public administration	101,009	4.8	816	3.1	.65	507	3.2	.67	100	2.9	.60

Source: U.S. Department of Commerce, 1980 Census, General Population Characteristicts

99. TABLE A-5 shows that Cape Girardeau County specializes to a greater extent in six areas: (1) agriculture (LQ=1.12), (2) construction (LQ=1.09), (3) wholesale and retail (LQ=1.13), (4) personal services (LQ=1.03), (5) Entertainment and recreation services (LQ=1.13), and (6) professional and related services (LQ=1.24). There are deficiencies in all other areas, the most prominent being mining (LQ=.40) and public administration (LQ=0.65). These deviations may be important factors in determining regional economic stability. Over and under specialization tends to create disruptive business cycles, hampering growth. One of the reasons the study area has proven itself capable of steady growth is because it has not specialized to an extreme degree in any one industry. It has a well balanced industrial mix and can weather the adverse repercussions of national economic fluctuations.

100. Cape Girardeau County also contains a large number of industries which help provide a diversified economic base for its development. The county's industry has experienced a slow but steady growth in the number of establishments which is reflected in TABLE A-6. The value added by manufacture and annual wages has increased significantly during this same time period (1958-1972). The Southeast Missouri Regional Planning Commission reports in the Directory of Manufacturing and Basic Industries (April 1975) that the county at that time contained 117 industries and employed 5,862 persons in manufacturing. The two cities of Cape Girardeau and Jackson are the industrial centers of the county with 107, or 91.5 percent; of the county's manufacturers located within them. Jackson has 26 industries while Cape Girardeau City has 81 industries.

TABLE A-6
INDUSTRIAL TRENDS, 1958-1972
CAPE GIRARDEAU COUNTY

Year	Number of Establishments	Value Added by Manufacturing	Annual Payroll	Paid Employees
1958	79	$19,050,000	$10,723,000	3,490
1963	81	$32,502,000	$13,232,000	3,399
1967	80	$35,700,000	$16,700,000	3,700
1972	89	$71,300,000	$32,300,000	4,600

Source: US Census Bureau, Census of Manufacturers, 1958-1972.

RETAIL SALES

101. Since 1958, retail sales in Cape Girardeau County have increased nearly 168 percent while the total number of establishments has increased 7.4 percent. The rise in sales can be attributed partially to inflation, but the increase is also a result of the Cape Girardeau-Jackson area's growth as a regional center for commerce and trade. This is a trend that is expected to continue into the future.

102. TABLE A-7 reflects 1958-1972 retail trade figures for Cape Girardeau County.

BANK DEPOSITS

103. Bank deposits are another good indicator of economic activity. An analysis of the current financial status of the bank and savings and loan institutions in the county is provided in TABLES A-8 and A-9. Total assets and bank deposits in 1973 were more than 2-1/2 times their total in 1964. An indicator of the involvement of local banks in the development of the area is provided in the amount of State, county and municipal bonds held by the county's banks. During June of 1973 it is estimated that these totaled more than $24 million.

TABLE A-7
RETAIL TRADE, 1958-1972
CAPE GIRARDEAU COUNTY

Year	Number of Establishments	Total Sales	Paid Employees
1958	540	$ 50,087,000	1,997
1963	508	$ 73,161,000	2,707
1967	534	$ 88,119,000	2,756
1972	580	$134,112,000	3,403

Source: US Census Bureau as quoted in Cape Girardeau County Planning Commission, The Master Plan for Cape Girardeau County, Missouri, (May, 1977), pp. 104.

TABLE A-8
BANK DEPOSITS IN CAPE GIRARDEAU COUNTY, 1964

Total ($1,000)	Change 1960-64 ($1,000)	Time Deposits ($1,000)	Demand Deposits ($1,000)	Savings & Loan Assoc. Capital ($1,000)
47,607	+40.4	16,848	25,319	63,760

TABLE A-9
ASSETS OF FINANCIAL INSTITUTIONS, JUNE, 1973

Bank Assets (Millions of Dollars)

Number Of Firms	Total Assets	Total Deposits	Demand Deposits	Time & Savings Deposits	Loans	Bonds
5	122.42	110.13	48.91	61.22	62.96	24.91

Savings & Loan Association Assets (Millions of Dollars)

Number of Firms	Total Assets	Savings Accounts	Loans
4	182.96	150.11	174.51

Includes obligations of state and local governments, municpal bonds, etc.

SOURCE: Southeast Missouri Regional Planning Commission, The Economy of the Southeast Missouri Region: An Inventory and Education of Economic Resources, 1973.

OUTDOOR RECREATION AREAS

104. Heritage Conservation and Recreation Services (HCRS) Mid-Continent Region, Denver, Colorado, conducted the recreation survey and developed a "Level C Major Leisure-Time Investigation, 1 June 1978 revised 1 April 1980." This detailed technical data is documented and available for inspection at the St. Louis District, Corps of Engineers.

105. HCRS completed an inventory of parks for the metro area of Cape Girardeau-Jackson, 30 September 1976, and the report is on file in the District Office. Inside the watershed boundary there are 570 acres of parkland. Cape Girardeau County maintains 250 acres, and the city of Cape Girardeau has 320 acres. City parks outside the watershed amount to 117 acres.

106. In this report, because the city is an isolated entity within the county, the park supply was not limited to the watershed but considered the city limits as well as the watershed. A metro-county park is defined as a park having between 100-500 acres. District parks have 20-99 acres, and neighborhood parks contain 5-19 acres. Vest pocket parks have 2-4 acres. TABLE A-10 displays the existing park acreage according to park type, park name, jurisdication, and acreage. The definition of terms used in TABLE A-10 are as follows:

a. Partially developed: Parklands where the development of constructed park facilities is not complete.

b. Day use facilities: Parks with facilities intended for short time use such as picnicking, softball, swimming, etc.

107. The city of Cape Girardeau is seeking to enlarge its boundaries by annexation to the north of the existing boundary. The city is in the process of expansion in population as well as area. The last two Master Plans for the city have shown a firm commitment to enlarging recreation facilities and recreation acres.

108. The present administration and immediate past administrations have favored and implemented increasing amounts of recreation lands and opportunities as illustrated in TABLE A-10. However, at the present time there is no way to forecast the rate of growth for recreation lands or opportunities. The city has indicated they have no plans for more parks at this time.

TABLE A-10
CAPE LA CROIX CREEK AREA
EXISTING PARKS - 1980

PARK NAME	JURISDICTION	COMMENTS	ACREAGE
	METRO-COUNTY PARKS		
COUNTRY FARM	CAPE GIRARDEAU COUNTY	PARTIALLY DEVELOPED	230*
CAPE GIRARDEAU COUNTRY CLUB	CAPE GIRARDEAU COUNTRY CLUB	PRIVATE	(200)
KELSO-SPRINGDALE BIRD SANCTUARY	SOUTH EAST MISSOURI STATE UNIV AND AUDOBON SOCIETY	SEMI-PUBLIC	(135)
		SUBTOTAL	230
	DISTRICT PARKS		
ARENA	CITY OF CAPE GIRARDEAU	DAY USE FACILITIES	94*
SHAWNEE	CITY OF CAPE GIRARDEAU	PARTIALLY DEVELOPED	78*
TWIN TREES	CITY OF CAPE GIRARDEAU	DAY USE FACILITIES	63
JAYCEE PUBLIC GOLF COURSE	CITY OF CAPE GIRARDEAU	DAY USE FACILITIES	60*
CHEROKEE	CITY OF CAPE GIRARDEAU	PARTIALLY DEVELOPED	54*
CAPAHA	CITY OF CAPE GIRARDEAU	DAY USE FACILITIES	34*
CAPE ROCK	CITY OF CAPE GIRARDEAU	DAY USE FACILITIES	27
KLAUS	CAPE GIRARDEAU COUNTY	DAY USE FACILITIES	20*
		SUBTOTAL	430
	NEIGHBORHOOD PARKS		
DENNIS SCIVALLY	CITY OF CAPE GIRARDEAU	DAY USE FACILITIES	6*
MISSOURI	CITY OF CAPE GIRARDEAU	DAY USE FACILITIES	6
		SUBTOTAL	12

TABLE A-10 (Continued)

PARK NAME	JURISDICTION	COMMENTS	ACREAGE
		VEST POCKET PARKS	
COURTHOUSE	CITY OF CAPE GIRARDEAU	DAY USE FACILITIES	4
FORT D	CITY OF CAPE GIRARDEAU	DAY USE FACILITIES	3
ROCKWOOD	CITY OF CAPE GIRARDEAU	DAY USE FACILITIES	2
INDIAN	CITY OF CAPE GIRARDEAU	DAY USE FACILITIES	2
JAYCEE	CITY OF CAPE GIRARDEAU	DAY USE FACILITIES	2*
		SUBTOTAL	13
		TOTAL	685

* PARKS IN WATERSHED

PROBLEMS, NEEDS AND OPPORTUNITIES

109. In order to better define the problems in the study area, an intensive effort has been made to coordinate the study with appropriate agencies and to involve the residents of the study area in the planning process.

FLOODING AND FLOODPLAIN MANAGEMENT

110. The continuing growth in the study area has resulted in a number of water-related problems. The most apparent and serious of these problems are the needs for flood damage reduction and prudent use of floodplain lands. Two essentially independent types of flood problems affect the study area. Flash flooding occurs in the various small watersheds which comprise most of the study area. Flash flooding on Hubble Creek and its tributaries has resulted in minor urban flood damage in Jackson and agricultural damage in the southern part of the watershed. On 30 May 1973, a flash flood on Cape La Croix Creek and its tributary, Walker Creek, resulted in serious damage to residential and commercial areas in Cape Girardeau. A 9.71-inch rainfall in approximately 8 hours precipitated this flood event. Increased damage would result from more widespread and intense storms, such as the August 1974 11-inch rainfall in the Whitewater River basin west of the study area. The March 1977 storm caused extensive damage to the Cape La Croix Creek and Walker Branch developed areas, but little damage along Hubble Creek. Rainfall for this storm amounted to 7.52 inches at the Cape Girardeau Airport and 6.48 inches at Jackson. Additional possible flood events since 1977 based on the rainfall amounts shown as follows: 7-8 December 1978, 2.46 inches at Cape Airport 4.16 inches at Jackson; 25 February 1979, 3.23 inches at Cape Airport, 3.00 inches at Jackson; 29-30 March 1979, 2.73 inches at Cape Airport 2.33 inches at Jackson; 23-24 April 1979, 2.23 inches at Cape, 2.33 inches at Jackson; 3-4 June 1979, 2.29 inches at Cape, 2.47 inches at Jackson; 8-9 November 1979, 2.47 inches at Cape, 2.44 inches at Jackson; 23-24 June 1980, 2.01 inches at Cape, 2.90 inches at Jackson; 17 October 1980, 2.30 inches at Cape, 1.54 inches at Jackson; 19 June 1981, 1.90 inches at Cape, 3.66 inches at Jackson; 18-19 May 1981, 2.94 inches at Cape, 2.58 inches at Jackson; 30 January 1982, 4.8 inches at Cape airport; and 27 August 1982, 5.5 inches at Jackson and 3 to 4 inches at Cape Girardeau.

111. A second and equally serious type of flooding results from high water on the Mississippi River and the Little River Diversion Channel. Unprotected, highly developed floodplain lands along the Mississippi River north and south of downtown Cape Girardeau are flooded periodically and were inundated during the 1973 Mississippi River flood. The downtown area is protected by a Corps of Engineers floodwall and levee system. Approximately 5,000 acres of prime farmland along the north bank of the Little River Diversion Channel are flooded periodically by Mississippi River backwater. This farmland was completely inundated during the 1973 Mississippi River flood.

112. The flood damages in Cape Girardeau County due to the 1973 Mississippi River flood were estimated by the Corps of Engineers to be $3,161,000. These damages consisted of $667,000 in crop damages, $725,000 in rural property damages, and $1,769,000 in urban development flood damages. The existing Corps of Engineers protection for the city of Cape Girardeau is credited with preventing an additional $17,484,000 of urban flood damages. These estimates are comparable within the limits of accuracy of flood damage estimation practices, with the slightly higher estimates of the Southeast Missouri Regional Planning Commission.

113. The 1973 flash flood on Cape La Croix Creek and the 1973 Mississippi River flood were natural disasters which could recur or be exceeded in magnitude in the succeeding years. The 1973 Mississippi River flood at Cape Girardeau was estimated to have a five percent chance of being equalled or exceeded in any one given year. The recurrence probability of the 1973 flash flood on Cape La Croix Creek has not been estimated.

a. The flash flood of March 28, 1977 was estimated to have cost up to $5 million in damages according to officials. State Disaster Planning Official James Houston found tractor trailers sunk off the highway, new and used car businesses up to their windshields in water. Hundreds of homes and retail businesses had several feet of water. Commercial plants had heavy equipment, dies and machinery damaged and destroyed. Inventories were literally washed away. The number of homeless were in the hundreds.

b. A significant flood occurred on June 19, 1981. This flood was less severe than 1977, yet some 2.7 inches of rainfall caused basements and commercial business to flood. Again inventory, automobiles, and equipment were damaged.

c. The most recent flash flood occurred on August 27, 1982 where city officials estimated the flood damages approached a million dollars. This flash flood began shortly after midnight causing roads, bridges, and utilities to be cut off. Many automobiles, inventory, and lower lying structures were flooded.

114. Residents of the Cape Girardeau-Jackson area and their elected representatives are aware of the seriousness of these flooding problems. Local interests have constructed a number of projects to alleviate flooding. A levee to protect against Hubble Creek flooding has been constructed in the city of Jackson. A number of small, private levees have been built to protect the agricultural areas north of the Little River Diversion Channel. In addition, local interests have undertaken a limited amount of channel clearing and straightening in Cape La Croix Creek and at the lower end of Goose Creek south of the corporate limits of Jackson. Local interests have cooperated in the Federally assisted floodwall and levee project that protects downtown Cape Girardeau.

115. Concern about the flood problems has also prompted local interests to support several flood control studies. Flood protection for the agricultural parts of the Hubble Creek watershed was actively pursued by local farmers through the SCS program. Local concern has also resulted in Congressional authorization of several Corps of Engineers flood control studies, including the Mississippi River at Cape Girardeau Study, the Little River Diversion Channel, the Cape La Croix Creek Study, and the more comprehensive Cape Girardeau-Jackson Study. At the 3 April 1975 Cape Girardeau-Jackson public meeting, considerable interest was expressed in finding solutions to the continuing flood problems in the Hubble Creek watershed, in the Little River Diversion Channel area, in the Cape La Croix Creek watershed, and in the parts of Cape Girardeau which are still subject to Mississippi River flooding.

116. The opportunity to reduce future flooding and streambank erosion that could result from the area's projected urbanization has also been recognized. Planning for the wise use of floodplain lands has been included as one aspect of the study. Cape Girardeau and Jackson are participating in the Federal Flood Insurance Program.

ENVIRONMENT

117. The environmental problems, needs, and oportunities are discussed under the topics of terrestrial community improvements, aquatic community improvements, erosion control, wastewater management and water quality, water supply, endangered species, wetlands, litter and debris control, and cultural resource properties.

118. Terrestrial Community Improvement. Extensive urbanization within the watershed has reduced the amount of undeveloped areas that are the primary habitats for terrestrial wildlife. Particularly significant has been the loss of bottomland forest habitat. This cover type is of fairly limited distribution, occurring only in the floodplains of rivers and creeks. Riparian bottomland forest has been eliminated from much of the creek within and below the city of Cape Girardeau. The net result has been a loss of food, cover, and travel lanes for wildlife.

119. The loss of terrestrial habitat within an urban context has also created a biologically sterile environment with little opportunity for observing wildlife. Recent economic statistics indicate that there may be a considerable public interest in nonconsumptive wildlife use opportunities such as birdwatching, birdfeeding, and wildlife photography. DeGraaf and Payne (1975) concluded that the total direct expenditures attributable to the enjoyment of nongame birds in the US during 1974 was approximately $500 million. Wildlife observation activity, defined as trips made primarily to see wild animals in a natural setting, was estimated in 1975 to include 27 percent of the total US population. Estimations of the degree of participation in specific nonconsumptive activities include 5% for birdwatching, 2% for bird and wildlife photography and 20 to 25% of US households participating in birdfeeding.

120. Publicly accessible habitat areas close to an urban setting appears to be the key to providing good opportunity for nonconsumptive wildlife use. Woody vegetation is the prime habitat element that must be present in order to support the highly diverse and productive populations of breeding birds that are the chief focal point for such nonconsumptive wildlife use. Except for backyard settings, the city presently provides little opportunity for this type of activity.

121. Project measures designed to provide access to publicly owned and managed habitat areas, or that improve backyard habitat areas, would greatly enhance conditions for wildlife and also provide opportunities for nonconsumptive wildlife use.

122. Aquatic Community Improvement. A healthy aquatic ecosystem will have a diversity of habitat types. Only a few pools which provide water, food, and shelter for aquatic organisms remain in the southeastern lowlands portion of Cape La Croix Creek. The removal of riparian trees have allowed the water in the creek to increase in temperature during the summer, having an adverse impact on the aquatic ecosystem. Trees provide habitat for food organisims (insects, caterpillars, etc.), provide bank stabilization, and create pools by backing up water or diverting the water so that it will create a pool. The decrease in aquatic and riparian habitat results in a decrease in fish species and populations. The loss of these habitats has resulted from past channelization efforts, caused by increased urban development and farming practices. There is a need and an opportunity to develop project measures that reduce or reverse the effects of this habitat degradation.

123. Erosion Control. Severe bank erosion is evident at numerous locations along the creek system, particularly at the sharper bends along the lower section of Cape La Croix Creek. Contributory to this problem has been the loss of bank stabilizing vegetation due to past flood control activities, and the encroachment of urban/agricultural development on the floodplain. The effect of increased runoff due to the watershed's expanding development has likewise intensified the problem. There is a need to provide erosion control along the creek.

124. In addition to project related channel improvements, opportunity for erosion control could come from measures that place creekside corridors and other undeveloped floodplain areas under public ownership and regulation.

125. Wastewater Management and Water Quality. As discussed earlier, water quality was found to be generally acceptable during the 1975 sampling period. Cape Girardeau's Master Plan indicates that a considerable increase in the area's industrial, commercial, and residential development can be expected in the near future. This growth is anticipated to bring with it a host of potential point and nonpoint sources of pollution. It is assumed that existing and future needs to improve water quality conditions will be satisfied through the

enforcement by other agencies of all Federal and state Clean Water Laws. The present investigation provides an opportunity for making recommendations supportive of the clean water efforts of other agencies, and also explores potential project measures conducive to good water quality management.

126. Water Supply. The extensive groundwater resource and the proximity of the Mississippi River and the Little River Diversion Channel are evidence that the future water supply demands of the study area can surely be met. The problem will be one of timely implementation of the most economic water supply systems.

127. Endangered Species. The protection of Federally threatened and endangered species and their habitat was made a national priority in 1973 with the enactment of the Endangered Species Act. Potentially occurring within the project area are two nationally endangered species: the bald eagle and the peregrine falcon. There is a need for the District: (1) to evaluate the probability of these species residing within the project area; (2) to determine the magnitude of project impact on these species; and (3) to develop measures that could be implemented to minimize adverse impacts to endangered species or their habitat. Opportunity exists via the Corps' planning process and through coordination with the USFWS to address these stated needs.

128. Wetlands. The wooded swamp/marsh complex located near the junction of Highways 61 and 74 is a relic of what was once an abundant resource within the Mississippi River floodplain. Most of the floodplain wetlands have been lost as a result of draining and/or filling for industrial, commercial, residential, and agricultural purposes. Portions of the wooded swamp area are now being filled in, and within the near future it is anticipated that this entire area will be lost to industrial development. Wetlands serve many useful functions, such as natural flood control, improved water quality, recharge of aquifers, flow stabilization of streams and rivers, and provide a unique kind of habitat for certain fish and wildlife. They provide recreational opportunities and have scientific and aesthetic values of national interest.

129. There is a need to preserve our nation's remaining wetlands. The present project provides an opportunity to alert the public to the importance of the watersheds' last major wetland area and to encourage consideration of this area for protection.

130. Litter and Debris Control. Another need related to the environment is litter and debris control in and along the stream corridor. A need exists to better control dumping and littering. Such debris acts as a hydraulic impediment and degrades the aesthetic and environmental quality of the watershed.

131. Cultural Resource Properties. During the 1977 and 1982 Cultural Resource surveys, archeological and historical properties were located within the study area. Nationwide and regionally many such sites are being lost as a result of urbanization and other human induced land use changes. Since the implementation of a project could also infringe upon such areas, there is both a project need and a project opportunity to protect such locations. Opportunities are afforded via site evaluations, careful planning and coordination, and resource recovery mechanisms.

RECREATION

132. The Cape Girardeau-Jackson area affords numerous opportunities for recreation and for fish and wildlife conservation. The study area is surrounded by high quality recreation lands. The Ozark region to the west is characterized by rolling, forested hills and clear, spring-fed streams and rivers. Parts of Clark National Forest and numerous state parks and other recreation facilities are located in the SEMORPC planning area. Trail of Tears State Park is located in the northern part of the study area. The Shawnee National Forest area, in Illinois, east of Cape Girardeau, provides numerous recreation opportunities. The Mississippi River and its floodplain also has great potential for meeting fish, wildlife and related recreation needs. Cape Girardeau County accounts for almost half of the tourist business in the seven-county SEMORPC region. Outdoor recreation is one of the major industries in the Cape Girardeau-Jackson area. Tourist expenditures in the study area exceeded $8,000,000 in 1967.

133. According to the 1972 Outdoor Recreation and Open Space Plan for the Southeast Missouri Region, both Cape Girardeau and Jackson have existing and projected needs for urban open space and recreation areas. Since Lake Boutin in Trail of Tears State Park was closed to swimming in May 1969 because of high bacteria counts, the area has lacked an outdoor lake swimming facility. Both cities have developed plans for small lakes that could serve recreation, flood control, and/or water supply purposes. Civic groups in Jackson are currently pursuing the development of a lake in that community. Lake development plans are not being pursued in Cape Girardeau at present. Both cities have also developed general plans for neigborhood parks in flood-prone areas and linear parks adjacent to streams. The preservation of the high quality environment in and around the many beautiful streams in the study area is considered to be an opportunity that will enhance the long-term desirability of the Cape Girardeau-Jackson area. The objectives of flood control, floodplain management, recreation, and fish and wildlife conservation could be concurrently served by such action.

134. The NPS through the former Heritage Conservation & Recreation Services (HCRS) Mid Continent Region, Denver completed a recreation survey of the metropolitan area of Cape Girardeau-Jackson. HCRS also completed a "Level C, Major Leisure-Time Investigation" on 1 June 1978 revised 1 April 1980 which are on file.

135. The survey of recreation in the Cape Girardeau-Jackson metropolitan area showed no immediate need for additional recreation acres. The survey was based on the 210-square mile metropolitan area. The analysis examined recreation resource units, i.e., regional parks, neighborhood parks, etc. A detailed study of recreation activities of the watershed and the city of Cape Girardeau reveals different facts that do not support the overall view of adequate recreational opportunities. The study points out that numerous recreational opportunities are indeed in short supply.

136. The Recreation Market Area (RMA) was established to include the watershed of Cape La Croix Creek and the city of Cape Girardeau (TABLE A-6). The RMA is considered to be that area from which approximately 80 percent of the recreation use will be generated. (See HCRS: Cape Girardeau, Mo., Cape La Croix Creek, p. 4.) Approximately 95 percent of the population resides in the city limits and 5 percent in the remaining watershed.

137. The potential recreation resource sites were identified and examined during a field trip in July 1976. Each site was visited and evaluated by an HCRS staff member and a Corps employee. Sites were selected for a variety of reasons, namely: environmental conditions, location, proximity to the creek, and suitability for selected recreational use.

OTHER WATER RELATED PROBLEMS AND OPPORTUNITIES

138. Local interests have also indicated that there is a need to improve navigation facilities in the Cape Girardeau area. A Southeast Missouri

Regional Port Authority has been formed to investigate and develop port facilities in the area. Navigation and port needs are not being addressed in the Cape Girardeau-Jackson water resources study, because the St. Louis District, Corps of Engineers is conducting a Small Navigation Study for the Cape Girardeau area under the continuing authority of Section 107 of the River and Harbors Act of 1960.

139. In summary, the present and potential serious water-related problems in the study area include flash flooding and Mississippi River flooding. Opportunities include floodplain management, outdoor recreation, and the protection and enhancement of environmental and aesthetic qualities in the study area. Since many of the study area's water-related problems and opportunities are interrelated, there is also a need for comprehensive water resources planning in the Cape Girardeau-Jackson area.

TABLE A-11
CAPE LA CROIX CREEK RMA SUPPLY
INVENTORY COMPARISON

	1978	1980	Difference
Private	112	200 (1)	88
City	275	685	410
School Board	48	135 (2)	87
Quass - Public	60 (3)		-60
State - Federal	1200	1200	0
	1695	2220	525

(1) Adjusted Total

(2) Kelso-Springdale Bird Sanctuary has been increased in size. This area is jointly owned and administered by Southeast Missouri State University and the Audubon Society as a natural area. Bird watching and hiking are the two activities that take place in the area.

(3) The Jaycee Public Golf Course is now owned by the city of Cape Girardeau. It should be noted that the net supply of golf course has not changed.

CAPE GIRARDEAU-JACKSON

METROPOLITAN AREA, MISSOURI

SURVEY REPORT

APPENDIX B

PLAN FORMULATION, ASSESSMENT, AND EVALUATION

CAPE GIRARDEAU-JACKSON
APPENDIX B
PLAN FORMULATION, ASSESSMENT, AND EVALUATION

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CAPE GIRARDEAU-JACKSON
APPENDIX B
PLAN FORMULATION, ASSESSMENT, AND EVALUATION

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CAPE GIRARDEAU - JACKSON
APPENDIX B

PLAN FORMULATION, ASSESSMENT, AND EVALUATION

INTRODUCTION

1. The purpose of this appendix is to describe the plan formulation process used to arrive at the Recommended Plan. Included is a discussion of those parts of the formulation process needed to understand the rationale for the final array of alternative solutions and the Recommended Plan.

PLANNING APPROACH

2. The term plan formulation is used herein to describe the systematic approach followed to arrive at the planning conclusions and recommendations. Water resources planners commonly use an iterative four task plan formulation process which was adopted for this study. A three stage plan formulation process was used to conduct this study. Each stage consists of four planning tasks: (1) problem and opportunity identification (2) formulation of alternatives (3) impact assessment and (4) evaluation. With each subsequent stage each of the tasks carried forward are examined in greater detail. In stage 1 emphasis is placed on defining the scope and character of the study as a guide to subsequent planning. The primary emphasis is on the identification of problems, needs and opportunities with the remaining three tasks being more thoroughly pursued in Stages 2 and 3.

3. The second stage emphasizes the identification and analysis of all alternative solutions to the problems and needs. Detailed engineering and design are not pursued during this stage. Impact assessment and evaluation of alternatives are pursued with limited detail sufficient to reveal significant consequences and outputs. Stage two provided an array of alternative solutions that address the planning objectives, provides choices between resource management options and identifies the alternatives to be considered in Stage 3.

4. During stage 3 alternatives are modified and screened to obtain a final array of implementable plans from which a plan can be selected for recommendation. All studies conducted are monitored and reviewed by a inter-disciplinary team of technical experts among which were professional engineers, economists, geologists, hydrologists, landscape architects, environmental scientists, and other professionals. A similar set of experts with the Corps of Engineers Lower Mississippi Valley Division in Vicksburg, Mississippi, reviewed all significant decisions and conclusions. Additionally, professionals with other Federal, state and local agencies were sought out for their special knowledge and opinions, as were faculty members at universities and colleges. Meetings with the local sponsor, city of Cape Girardeau officials and private

citizens helped to insure that practical and implementable solutions were being investigated. The final array of plans are designed, assessed and evaluated at the same level of detail and a recommended plan selected. This Survey Report documents the completion of this effort.

PLANNING OBJECTIVES

5. The analysis of the problems and opportunities described in APPENDIX A led to the establishment of the planning objectives for this study. A significant flooding problem exists along Cape La Croix Creek and Walker Branch. Flood control improvements for the remainder of the study area, including the city of Jackson and the rural area along the Little River Division Channel, were not economically justified at this time. Therefore, the planning objectives focus on Cape La Croix Creek and Walker Branch. These objectives are:

a. Reduce the incidence and amount of damage from flooding in the urban and urbanizing areas of the Cape La Croix Creek watershed.

b. Properly manage and make wise use of floodplain lands in rural, urban, and especially in urbanizing parts of Cape La Croix Creek and Walker Branch.

c. Minimize streambank erosion.

d. Improve water quality.

e. Safeguard and enhance the quality of the natural environment.

f. Protect and enhance the scenic beauty and other aesthetic qualities of Cape La Croix Creek and Walker Branch.

g. Improve the quantity and quality of outdoor recreation opportunities in the Cape La Croix Creek watershed to meet the projected needs, with special consideration given to flood-prone lands adjacent to watercourses.

PLANNING CONSTRAINTS

6. A number of specific criteria were established in the technical, economic, environmental, and evaluation fields to aid in the plan formulation process. These criteria were essentially constraints placed upon this process. These planning constraints were the following.

7. <u>Technical Criteria</u>. Technical criteria are guidelines directly affecting physical design features. The technical criteria used were:

a. The components of the final array of plans must be realistic;

b. Equal consideration must be given to nonstructural and structural approaches;

c. All nonstructural and/or structural measures recommended must be implementable from an engineering standpoint and under the specific site conditions;

d. The final array of alternative solutions must in general strive for the highest practicable levels of urban flood protection as a direct means of addressing intangible urban flood hazards and the basic welfare and safety of future generations.

e. The final array of alternative solutions must address all flood problems on a system-wide and deal comprehensively with impacts.

f. The final array of alternative solutions must provide realistic uniformity of urban flood protection and avoid alternatives which do not solve any severe and/or potentially catastrophic flood problems.

g. All nonstructural and structural measures must not impede any potential future flood fight efforts. That is, they must not make future flood fighting conditions more difficult than they are presently.

8. Economic Criteria. Specific economic criteria were used to analyze alternative plans. These economic criteria were:

a. The sum of tangible plus intangible benefits must exceed project costs.

b. Each separable unit of improvement must provide tangible plus intangible benefits, at least equal to its costs.

c. The scope of development must provide the maximum realistic net benefits possible and should not be significantly detrimental to intangible considerations.

d. All analysis must be based on a uniform price level (October 1983).

e. Annual costs and benefits must be based on a 100-year period of analysis.

f. All average annual calculations must be based on the prevailing interest rate (8-1/8 percent).

9. Environmental Guidelines. Environmental guidelines were established to insure that the environmental quality was taken into consideration.

The following criteria were used as guidelines during the formulation process:

a. The natural environment will be protected and enhanced wherever possible.

b. Should the imposition of detrimental environmental impacts be unavoidable, appropriate mitigation measures should be included.

c. The protection and enhancement of public health, safety, and social well-being will be maximized wherever possible.

10. Evaluation Measures. To provide a means for testing and evaluating relative plan performance, specific evaluation measures were applied. These measures were:

a. Assess the workability and viability of each plan regarding its acceptance by the affected publics and its accommodation of known institutional constraints (acceptability test).

b. Appraise the technical performance of each plan and the level of contribution to the planning objectives (effectiveness test).

c. Assess whether all necessary investments or other actions necessary to assure full attainment of the plan are included (completeness test).

d. Assess the plan's ability to achieve the planning objectives in the least costly way (efficiency test).

11. Additional Formulation Criteria. The following criteria were also imposed on the general planning process to assure that a plan would be found that was realistic, economically sound and implementable.

a. Average annual net induced damages must not exceed $10,000, and must be significantly offset within the entire system analysis.

b. Improvements that could create significantly hazardous or catastrophic situations in the event of unexpected failure of those improvements must be avoided.

c. In order to provide a conservative margin of economic justification, all plans of improvements were initially screened on a minimum performance of 1.4 benefits versus costs. This austere criterion was intended to help assure that the final proposal is economically sound even with uncertain future economic conditions.

STAGE 1 FORMULATION SUMMARY

12. The purposes of Stage 1 of the Cape Girardeau-Jackson study were: (1) to determine the scope of the study; (2) to determine the specific constraints acting upon the study; (3) to specify how subsequent planning activities would be accomplished; and (4) to accomplish the four planning tasks. During this initial stage, emphasis was given to Task 1, the identification of problems and opportunities, and determination of the planning objectives. The other three tasks were accomplished conceptually. Stage 1 of the Cape Girardeau-Jackson study culminated in the Plan of Study report.

13. In Stage 1, the studies were concentrated on problem identification for each of the water resources study purposes authorized by Congress. The logic was to identify first the problems and opportunities in the 210-square mile study area and then to determine if plans should be developed.

14. The Stage 1 studies disclosed that wastewater management problems were being adequately addressed under other programs, and that additional wastewater management studies would be unnecessary unless a serious need for such studies was demonstrated later. It was also found that local interest addressed water supply needs adequately. It was decided that water supply should only be examined in conjunction with plans developed for other study purposes.

15. The Stage 1 studies revealed that flooding problems were being experienced along Cape La Croix Creek, Sloan Creek, Hubble Creek, Ramsey Branch, Juden Creek, and Indian Creek, and in floodplain areas adjacent to the Little River Diversion Channel and the Mississippi River. Plans addressing these flooding problems were conceptually developed in Stage 1. Costs and benefits for the conceptual plans were not actually developed. However, based on the apparent damages and possibilities for alleviating these damages, it was recommended that more detailed studies should be made.

16. Plan formulation in Stage 1 was limited to establishing and testing a general planning approach. The approach adopted was based on the Corps of Engineers guidance entitled, "Planning Process: Implementation of Principles and Standards and Other Related Requirements." Only conceptual and judgmental management measures and plans were used to test and refine the planning approach during Stage 1 work. The results of this effort are described in the Stage 1 report "PLAN OF STUDY, A COMPREHENSIVE WATER RESOURCES MANAGEMENT STUDY FOR THE CAPE GIRARDEAU - JACKSON METROPOLITAN AREA, MISSOURI", July 1975. This report indicates that the Stage 1 initial iteration was successful. There appeared to be some practical solutions to the problems identified. The Stage 1 planning iteration is summarized below in terms of the four previously mentioned tasks.

PROBLEM AND OPPORTUNITY IDENTIFICATION - TASK 1

17. In Stage 1, the first planning task, identification of problems and opportunities, was emphasized. The Stage 1 iteration verified the existence of specific problems and opportunities that were basic to subsequent efforts. It was decided that the initial work effort in Stage 2 would be to focus intensively on the identification of each specific problem and opportunities for its resolution.

FORMULATION OF ALTERNATIVES - TASK 2

18. A great deal of data required to formulate comprehensive plans was unavailable for the Stage 1 iteration. Hence the planning approach was tested and refined by using general assumptions and conceptual plans in this iteration.

19. The first step accomplished during the formulation of alternatives was the development of 23 conceptual management measures by an interdisciplinary team. These measures ranged from nonstructural zoning proposals to levees, channelization, regional wastewater management facilities, and reservoirs.

20. In the Stage 1 planning iteration, five conceptual comprehensive alternatives formulated were:

a. A plan with emphasis on nonstructural measures.
b. A National Economic Development (NED) plan.
c. An Environmental Quality (EQ) plan.
d. A plan with emphasis on local implementation.
e. A judgmental selection by an interdisciplinary team of a mixture of management measures and systems.

21. Based on the experience gained during the Stage 1 planning iteration test, it was determined that during Stage 2, a major effort would be made to limit drastically the number of management measures and systems to those which were deemed implementable.

IMPACT ASSESSMENT - TASK 3

22. In Stage 1 the impacts of the conceptual comprehensive alternatives were systematically identified and assessed through the use of a matrix. Impact indicators were selected and organized into the following groups: NED impact indicators, EQ impact indicators, Social Well Being (SWB) impact indicators, and Regional Development (RD) impact indicators. In all, 100 indicators were selected. Each management measure was compared with each impact indicator. In Stage 1, the impacts of the management measures were described as being nonexistent, negative, or positive, with an intensity scale of major, moderate, or minor. The without project condition and one comprehensive alternative plan was tested with this impact assessment technique during Stage 1.

EVALUATION - TASK 4

23. The first effort in the Stage 1 evaluation task was to determine whether the planning objectives could be met. An abbreviated system for the appraisal of planning objective fulfillment was adopted. In this system, the management measures, composing a given comprehensive alternative, are compared with the planning objectives.

24. The second effort in Task 4 was the appraisal of national objective fulfillment, i.e., NED, EQ, SWB, and RD. In the Stage 1 iteration, this appraisal consisted of discussions between members of the interdisciplinary planning team. It was determined that problems existed. A list of measures that would alleviate the problems was developed.

25. The third effort in Task 4 was the appraisal of the fulfillment of the specified evaluation criteria. These require that each comprehensive plan be appraised as to it's acceptability, certainty, completeness, effectiveness, efficiency, equity, geographic scope, NED benefit/cost ratio, reversibility, and stability. In the Stage 1 iteration, this appraisal was accomplished by a judgmental team decision process based on the limited data available. This evaluation indicated that practical solutions to the problems existed, and that more detailed studies should be undertaken.

26. The fourth effort in Task 4 involved the appraisal of system of accounts fulfillment.

27. The fifth effort in Task 4 of the planning approach is a trade-off analysis. However, because of the conceptual nature of the Stage 1 comprehensive plans, no trade-off analysis was performed.

28. The subsequent two Task 4 efforts, designation of the NED and EQ plans, and determining of the Federal interest in each comprehensive alternative, could not be done meaningfully during the Stage 1 iteration.

29. The final effort in Task 4 of the Stage 1 iteration was to specify the basis for Stage 2. This very important effort resulted in the preparation of the refined planning approach as described in the July 1975 Plan of Study.

30. In summary, the Stage 1 planning iteration served the purpose of testing and refining the technical planning approach and process for the Cape Girardeau-Jackson study. An array of possible solutions were identified which would alleviate the problem. During Stage 2 these solutions will be screened further.

STAGE 2 FORMULATION SUMMARY

31. Plan formulation in Stage 2 was concerned with the development of an array of plans which, through the formulation process, addresses area problems, needs, and study objectives. From this broad spectrum of plans the most promising plans were identified and were recommended to be carried forward into Stage 3. The results of Stage 2 were published in "WATER RESOURCES INVESTIGATION CAPE GIRARDEAU-JACKSON METROPOLITAN AREA, MISSOURI-12053," dated October 1980. In the Stage 2 planning iteration a broad array of plans was developed.

32. The importance of Stage 2 formulation was that a broad spectrum of the most promising alternative plans was established and tested. The management measures from which the alternative plans were established considered the following: levees; floodwalls; detention basins; channel modifications; diversions; aquatic habitat structures; fish ponds; permanent relocation; floodplain regulations; floodproofing; land acquisition; fish and wildlife management; and litter and debris control. The study indicated that flood control improvements would only be justified on Cape La Croix Creek and Walker Branch.

33. The Stage 2 formulation work was based on considerably more sophisticated technical planning data and computer assisted analyses then were used in Stage 1. First, basic 2-foot contour maps were prepared. Pertinent data from these and hydraulic/hydrologic field data, surveyed cross sections, and precipitation data/analysis were loaded into appropriate computer programs. These calculations of expected flood flows and flood elevations were then calibrated (i.e., checked) against known past events. Concurrently, economic, structural and real estate information was collected to allow a clear understanding of the magnitude of potential future flood damages. Next, flood control management measures, both structural and nonstructural, were tested in various combinations by computer simulation to establish the flood control effectiveness of alternative potential solutions. The probable construction and operational costs for the various alternatives were estimated to allow determination of which solutions worked best and most efficiently. The iterative plan formulation approach previously described was used to identify those plans that performed best. The analytic methods and techniques and the detailed data enhanced the evaluation processes. Thus the results were much more detailed and more conclusive than the initial Stage 1 preliminary judgmental findings.

34. Formulation of the Stage 2 alternatives, procedures, and outputs were:

PROBLEM AND OPPORTUNITY IDENTIFICATION - TASK 1

35. The initial Stage 2 work activities consisted of a check and detailing of the first planning task - problem and opportunity identification. Corps interdisciplinary planning team members conducted

intensive field trips and interviews with local citizens to verify the extent and magnitude of the flooding and related water resources problems. Outdoor recreation and environmental resource personnel specified existing problems and then expanded their analyses to identify all opportunities for enhancement of the areas resources. No restraints were initially placed on the range and/or scope of problem/opportunity identification to insure comprehensiveness. Areas and opportunities beyond the relevant floodplain areas, and externalities were studied to determine possible synergistic impacts.

36. The results of the Stage 2 iteration of the problem and opportunity identification planning task fully supported the Stage 1 results.

37. Flood damage mitigation was verified as the primary local need and objective. Community development was and continues to be centered around and within some floodplain areas. An appropriate means to mitigate flood losses concurrent with environmental and outdoor recreational enhancements remained the basic objective.

FORMULATION OF ALTERNATIVES - TASK 2

38. The formulation of alternatives consisted of first detailing all known potential management measures that addressed the objectives. Next a specific plan formulation approach and rationale was prepared to develop, assess, and evaluate alternative solutions so as to progress systematically to the alternatives that were to be developed. This approach was designed to identify applicable solutions. The plans of all other Federal, state, and local agencies that might impact this study were recognized to insure that no duplication or conflict in approaches and/or solutions would occur. A summary of the work leading to the formulation of the Stage 2 alternatives and a description of those alternatives follows.

39. Management Measures. A management measure is a structural or nonstructural means to manage water and/or related land resources in such a way as to address the planning objectives. Each management measure can be part of a plan or the entire plan by itself. Examples of structural management measures are channel modifications and levees. Examples of nonstructural management measures are floodproofing and floodplain regulations. The management measures that could be used to address the planning objectives were:

a. Levees and Floodwalls: Physical barriers erected between stream channels and damageable property.

b. Detention Basins: Catchments that temporarily store and safely discharge the flow of stormwater.

c. Channel Modifications: Alterations to stream channels to improve conveyance capacities.

d. Diversion: A conveyance system used to reroute existing stream channels.

e. Watershed Treatment: The treatment of soil to increase its ability to absorb and retain excessive precipitation.

f. Aquatic Habitat Structures: In-stream structures that produce pools and aquatic sanctuaries.

g. Temporary Evacuation: The removal of damageable property until flood waters recede.

h. Permanent Relocation: The permanent removal of damageable property from the floodplain.

i. Floodplain Regulation: The restriction of the type, location, amount, and/or nature of development within a floodplain (e.g., floodplain zoning, building regulations, and easement acquisition).

j. Warning Devices: Signs erected in prominent locations warning observers that an area is within a flood hazard zone and/or alarms to indicate that high water conditions are threatening.

k. Tax Concessions: Tax incentives to encourage rational use of floodplain land.

l. Floodproofing: The altering of a damageable structure or its physical setting to reduce flood damage susceptibility (e.g., elevating in place, dikes, and watertight covers over openings.

m. Land Acquisition: The attainment of public control over land.

n. Fish and Wildlife Management: The manipulation of lands, vegetation, and aquatic habitat to the benefit of fish and wildlife.

o. Litter/Debris Clean-up and Control: (Self-explanatory.)

p. Fish Ponds: Pools created to increase the number and types of aquatic life.

40. Plan Formulation Rationale. The basic rationale for this study's plan formulation is contained within the Water Resource Council's Principals and Standards. The following paragraphs discuss the way the Stage 2 plan development, assessment, and evaluation was accomplished.

41. Plan Development. The procedure for plan development consisted of: (1) identifying problems, needs, and opportunities; (2) converting the needs and opportunities statements into operational planning objectives;

(3) identifying management measures that will address the planning objectives; and (4) developing an array of alternative plans. A single measure can be one alternative plan.

42. Plan Formulation Process. The plan formulation process just described (plan development, plan assessment, and plan evaluation) is regularly repeated to insure that nothing is overlooked. That is, the process is repeated at least once during each of the three study stages so that as the study progresses from one stage to the next, more precise alternative plans are developed. This iterative process helps to maintain flexibility and accommodates developments and changes as they occur.

43. Throughout plan formulation, the basic guidelines needed to provide the framework for plan development, assessment, and evaluation were modified and improved. The Stage 2 formulation criteria and assumptions were:

a. Formulation Criteria. Formulation criteria were identified for the technical, economic, and environmental aspects.

(1) Technical criteria established that all alternative plans must be realistic, not impede future flood fight efforts, and their design be applicable to the specific site.

(2) Economic criteria established that tangible plus intangible benefits should outweigh costs, and the scale of development must maximize benefits. Annual costs are to be based on a 100-year period of analysis while based on the prevailing interest rate.

(3) Environmental criteria were established to insure proper consideration of environmental factors along with economic efficiency. In general, it seemed desirable to protect the existing natural environment, and where degradation was unavoidable, suitable mitigation should measures be presented. Public health, safety, and social well-being must be protected.

(4) Evaluation criteria were used to test and evaluate the specific performance of plans. A plan's workability and viability was tested against institutional and public constraints. Technical performance, reversibility to without conditions, sensitivity, and scope of the plan was used. The plans were analyzed to determine contributions to the NED and EQ accounts.

b. Formulation Assumptions. The formulation of alternative plans often depends on a planner's perspective of projected future regional conditions. To document the Future Stage 2 formulation perspective used, the assumptions about future watershed conditions without an implemented plan ("no action") were specifically identified. These Stage 2 assumptions were based on Stage 1 decisions and the input of the members of the interdisciplinary team.

(1) General. Barring adversities such as war, depression, unusual inflation, or revolution, the general well-being of the residents in the watershed will not change significantly.

(2) Flood Protection. In the absence of this project, major flood control improvements are not likely to be installed within the study area. Local interests will implement flood protection measures that are within their capabilities to fund. Hazard mitigation programs will be utilized.

(3) Flood Insurance Program. Local units of government will participate in the National Flood Insurance Program. Existing structures within the regulatory floodplain will be insured by Federally subsidized flood insurance.

(4) Land Development. No new construction will occur at or below the 100-year exceedance interval flood level unless it is floodproofed to at least this level. There will be no intensification of development or locational advantage taken within the 100-year exceedance interval floodplain. Within this floodplain, existing structures will be removed if they cannot be returned to useful service following natural disasters or natural aging. The land use configuration of the watershed will be the same as that proposed by the SEMORPC. There will be no earthfills within the floodway for the purpose of elevating that land above the 100-year exceedance interval floodplain. Executive Order 11988 will be implemented.

(5) Population. The number of people residing in the study area watershed will be consistent with local population projections.

(6) Economic Development. The study area will experience economic development during the period 1980-2020.

(7) Environment. The Cape La Croix Creek stream corridor and adjacent lands are now and will be in the future of high quality in the rural segments and of low quality in the urban segments of the stream.

(8) Community Cohesion. The threat of flash flooding impacts negatively on business stability in the major business district along Cape La Croix Creek and Walker Branch.

(9) Recreation. The need for additional recreational opportunities in the Cape Girardeau area has not yet been met.

44. Analysis of Stage 2 Alternatives. The plan formulation accomplished during the Stage 2 studies focused on the identification and screening of the complete range of alternative single and multiple purpose solutions. This formulation approach was designed to proceed systematically from single purpose concerns directly to multipurpose plans. This study

approach minimized the work required to indicate the desirability of continuing the study into the Stage 3 search for NED, EQ, and Recommended Plans. Documentation to the Stage 2 report was prepared as a draft of the final survey report.

45. Stage 2 formulation consisted of creating and screening a total of sixteen plans. Twelve of these plans emphasized a single project purpose, and four plans addressed all three project purposes. This approach allowed for a clearer understanding of the individual nature of the three separate project purposes and their responsiveness to various management measures, as a technical data base from which to initiate multiple purpose planning. It demonstrated that the flood control, environmental, and outdoor recreational needs and opportunities could be successfully addressed on either a single or multiple purpose basis. Plans were specifically developed and tested as examples of whole families of similar plans using similar management measures. Stage 2 planning was carried only to a point where it was clear that an array of justified alternative solutions existed. Planning was not continued to identify the "best" alternative, as this would be part of Stage 3 endeavors. Plans consisting of management measures that exhibited a lack of justification and/or caused significant environmental/outdoor recreation damage were generally discarded from continued Stage 2 analysis. The Stage 2 approach resulted in: (1) screening out plans consisting of management measures that performed poorly, i.e., did not solve the problems, nor capture the opportunities; and (2) identifying plans consisting of management measures that performed well. It was intended that Stage 3 studies would be devoted to specifying a nonstructural alternative and other viable alternatives necessary to create a final array of alternative multiple purpose solutions from which the NED, EQ, and Recommended Plans were to be designated.

46. Formulation of Stage 2 Alternatives. The Stage 2 study began with assembling all available information followed by a field survey conducted to better define and identify information needed for study completion.

47. In the city of Cape Girardeau, Walker Branch and Cape La Croix Creek investigations identified that these creeks should be a combined study effort because of the commonality of the flood plain.

48. The formulation of alternative recreation plans addressed the outdoor recreation needs. Additional iterations were used to incorporate the recreational alternatives to a variety of flood control measures.

49. Analyses centered on identifying the maximum possible amount of open space for recreational use.

50. Two management measures were identified as a means of obtaining the maximum amount of open space for recreational opportunities, i.e.,

detention sites and the acquisition of linear open space along the stream corridor. The detention site considerations will be discussed first, followed by those dealing with linear open space.

51. Cape Girardeau - Focus on Outdoor Recreation.

a. Detention Site Consideration. Two dry detention sites were considered for flood control purposes, i.e., a ten-year site consisting of 78 flood acres (Site A), and a site of 112 acres (Site B), designed to capture the standard project flood (SPF). These sites were evaluated to establish the number of recreational acres needed. These were: (1) Site A, 124 recreation acres plus 78 flood control acres for a total of 202 acres; and (2) Site B, 163 recreational acres. These were added to the flood control acres of 112 providing Site B with 275 acres. These recreation acreage figures were considered as preliminary and to be subject to change during the formulation and coordination process.

b. Linear Park Consideration. During the process of examining the recreational opportunities along Cape La Croix Creek, it was recognized that the floodway provides a natural linear greenway. These open space lands are a significant portion of the remaining undeveloped open space area within the Cape La Croix watershed.

c. The proposed linear corridor connects some existing parks and proposed recreation locations. On Cape La Croix Creek, the 5.4 miles of hiking trails would provide a means of traversing from Missouri Highway 74 to US Highway 61 and provide a trail from Shawnee Park to Arena Park and to the highway. The Walker Branch segment with 2.4 miles will connect Scivaly and Cherokee Parks as well as parks on Cape La Croix Creek. An equestrian trail from East Rodney Boulevard to US Highway 61 would be 2.8 miles long.

52. In an effort to reduce severe damages from flooding in the Cape La Croix Creek and Walker Branch floodplains, several alternatives were examined. Initial plans considered various channel sizes and linings, numerous dry detention reservoir sites, wet reservoir sites, levees, and diversion channels.

53. Additional Alternatives. Other plans seemed to show economic potential and were analyzed using the HEC-1 and HEC-2 models. These plans were compared to the 1995 land use with the no project condition. The features of each plan were selected to test the economic feasibility of various sized channels and construction materials and techniques. These data are summarized and available for inspection from the St. Louis District Corps of Engineers, Urban Studies Branch.

54. A considerable volume of detailed data was assembled to accomplish the "Impact Assessment" and "Evaluation" of the sixteen Stage 2 plans. This information is documented and available for inspection from the St. Louis District Corps of Engineers Urban Studies Branch.

55. The Stage 2 studies accomplished the four planning tasks (i.e., problem/opportunity identificaton, formulation of alternatives, impact assessment, and evaluation) at a level of detail that produced suitable management measures. They helped also to focus on comprehensive alternative solutions. This Stage 2 work received strong local interest and support, and provided the technical foundation for the Stage 3 effort.

STAGE 3 FORMULATION

56. The initial Stage 3 work verified and further detailed the flood problems and refined the outdoor recreational and environmental needs and opportunities. The features of the final array of alternative potential solutions, along with a summary explanation of the specific reasons for their final configuration are presented in the following paragraphs.

57. The remainder of this appendix presents a summary of the final round of formulation of alternatives which led to selection of a plan for recommendation. As a means to summarize the procedure followed in selection of a Recommended Plan, the four general planning tasks will again be discussed. These four tasks are: (1) Problem and Opportunity Indentification; (2) Formulation of Alternatives; (3) Impact Assessment; and (4) Evaluation.

PROBLEM AND OPPORTUNITY IDENTIFICATION (TASK 1)

58. For the final formulation cycle, an office and field review of the study area revealed no new flood problems and/or opportunities that had not been previously considered. An informal check with local, state, and other Federal agency study participants verified that no new study area problems and/or opportunities had arisen or had been overlooked. Therefore, the problems and opportunities previously identified and discussed in this report remain as valid goals or objectives.

FORMULATION OF ALTERNATIVES (TASK 2)

59. The previous stage of formulation (Stage 2) developed 16 alternative plans. These plans included the alternatives which best emphasized NED performance, while others emphasized EQ, SWB, and RD performance. The plans analyzed during Stage 2 were based on the assumption that the channels of Cape La Croix Creek and Walker Branch below Independence Street to their confluence were one reach. The assumption was based on the hydrologic fact that the floodplain in this area was common to both creeks and the flooding, was not separable. During review, different analyses were required to demonstrate incremental feasibility. Twelve additional flood control alternatives were analyzed to determine the NED flood control plan and its economic justification.

60. The formulation of these additional 12 flood control alternatives treated the junction of Cape La Croix Creek and Walker Branch below

Independence Street as several reaches. These 12 plans are described below:

Plan 1 tested the justification of the detention site on Cape La Croix Creek as a first added increment. This provided net benefits, making this the first added increment.

Plan 2 tested the incremental justification of adding to the detention feature a small channel on both Walker Branch (Mile 0.00-2.00) and downstream from the junction on Cape La Croix Creek (Mile 2.70-3.143) with a small transition going upstream from the junction. This plan provided a decrease in net benefits from Plan 1 and, is not justified in isolation from the detention reservoir.

Plan 3 tested the incremental justification of adding to the detention feature a small channel on Cape La Croix Creek (Mile 2.7-3.76) including a small transition upstream on Walker Branch from its junction with Cape La Croix Creek. This provided a decrease of net benefits from Plan 1 and is not justified.

Plan 4 tested the incremental justification of adding to the detention feature a medium-sized channel on Walker Branch (Mile 0.00-2.00) and a small channel downstream from junction on Cape La Croix Creek (Mile 2.70-3.343). This plan provided an increase in net benefits over Plan 1 and was justified.

Plan 5 tested the justification of adding to the detention feature a medium-sized channel on Cape La Croix Creek, (Mile 2.7-3.76), including a small transition upstream from the junction on Walker Branch to the detention feature. This plan provided a decrease in net benefits from Plan 1 and is not justified.

Plan 6 tested the incremental justification of adding to Plan 4 a small channel on Cape La Croix Creek (Mile 2.7-3.76). This plan provided a decrease in net benefits from Plan 4 and is not justified.

Plan 7 tested the incremental justification of adding to Plan 4 an additional section of channel on Cape La Croix Creek (Mile 3.143-5.11). This plan provided a decrease in net benefits from Plan 4 and is not justified.

Plan 8 tested the incremental justification of increasing the size of the channel for Plan 4. This plan provided a decrease in net benefits from Plan 4 and is not justified.

Plan 9 tested the incremental justification to Plan 4 of increasing the size of the channel and of extending the channel on Cape La Croix Creek (up to Mile 5.11). This plan provided a decrease from Plan 4 and is not justified.

Plan 10 tested the incremental justification of adding to Plan 4 a small channel section on Cape La Croix Creek (up to Mile 3.76). This plan provided an increase in net benefits over Plan 4 and is justified.

Plan 11 tested the incremental justification of changing a channel section in Plan 10 on Walker Branch from concrete to grass. This change provided an increase in net benefits and is justified.

Plan 12 tested the incremental justification of the section of channel on Walker Branch (Mile 1.11-2.00) by deleting this section of channel from Plan 11. This change provided a decrease of net benefits yet it is justified.

61. This evaluation indicated that Plan 11 best maximized net tangible flood control benefits.

SPECIFIC FORMULATION ALTERNATIVES

DRY DETENTION STORAGE

62. Only one dry detention site was found to be economically feasible during earlier studies and it was carried forward and used in the final analysis. However, one result of the high degree of local interest in dry detention storage was that an additional effort was spent in analyzing other possible detention sites during the final analysis.

63. A member of the local Drainage District at the Stage 2 Public Meeting suggested the first of these sites. This site was designated site 1A and is located on Cape La Croix Creek just upstream of US Highway 61-34, near the northern city limits of Cape Girardeau. Due to the length of fill required and the cost of relocating Route W, the site would not be economically feasible. Therefore, the site was eliminated from detailed analyses.

64. A broader search for potential detention sites was then accomplished. The hydrologic model was examined to determine which of the subareas were significantly contributing to the peak flows of either Cape La Croix Creek or Walker Branch. Once these were identified, topographic maps and aerial photographs were used to select the most favorable potential sites. Factors considered in the analysis included size of catchment area, topography, and amount of development including roads, streets, utilities, etc.

65. Each dry detention reservoir site was analyzed independent of any other flood control component. HEC-1DB was used to determine the spillway crest elevations required to store the storms with a 10, 2, 1, and .02 percent chance of occurrence at each of the sites. First, the spillway crest elevation was assumed to be very high and each of the hypothetical storms was routed through the detention reservoir. The spillway crest elevations were then set equal to the maximum pool

elevation for each of the respective storms. Next, the PMF was routed through each of the four reservoir sizes with the top of dam elevation set very high. The actual top of dam was then established by adding four feet to the resulting maximum pool elevations to insure against overtopping. Therefore at each site, dry detention reservoirs with four storage capacities, spillway crests, and top of dam elevations were analyzed.

66. The dry detention reservoir at Site 2 was effective in reducing peak flows in the high damage reaches of Cape La Croix Creek. A benefit-cost analysis indicated that the reservoir with a capacity to store a storm with a 10 percent chance of occurrence was the optimum reservoir size. This feature was economically justified and was therefore included as a component in the analyses of alternative plans.

67. Although the dry detention reservoir at Site 3 reduced peak flows from subarea 70, the peak discharge was sufficiently delayed to allow more flow to be added to the peak hydrograph of Cape La Croix Creek than if a reservoir was not included. Therefore, the dry detention reservoir at Site 3 was eliminated from subsequent analysis.

68. Dry detention reservoirs at Sites 4 and 5 were ineffective in reducing peak flows in the high damage reaches of Walker Branch. Also, recent residential developments in the vicinity of the two sites made costs prohibitive. Therefore, no further consideration was given to dry detention reservoirs at Sites 4 and 5.

69. Subsequently, at the request of the local Drainage District, three more sites (6, 7, and 8) were investigated for dry detention storage. Dry detention Site 6, located upstream of Site 2 on the main stem of Cape La Croix Creek, was analyzed as an alternative to Site 2 since residential development was expected at the latter. However, Site 6 was not as effective in reducing peak flows and a benefit-cost analysis showed that it was not economically justified.

70. Site 7, located just upstream of Hopper Road on Cape La Croix Creek is an area that presently acts as a natural flood storage area due to the Hopper Road fill and small bridge opening. The bottomland is primarily undeveloped but is bounded by Mt. Auburn Road on the west, Highway 61-34 on the north, and residential development including Hawthorn School on the east. After reviewing topographic maps and aerial photographs of Site 7, it was determined that this site was not a feasible location for a dry detention reservoir due to the costs involved in raising Mt. Auburn Road and Highway 61-34, and in providing special protection of several homes and commercial structures that would be periodically inundated as a result of the reservoir.

71. Site 8, located immediately upstream of Route W on Cape La Croix Creek was similarly reviewed and was eliminated due to the costs involved in raising or protecting Route W, relocation of several residences and a sewage treatment plant for a large nursing home complex.

CHANNEL IMPROVEMENTS

72. Alternative solutions utilizing the full range of potential channel improvements, including various combinations, were considered. The channel improvements that provided the best flood control performance included concrete, riprap, and grass-lined channels. Trapezoidal and vertical walled channel improvement configurations were considered. The impacts of the various channel types and sizes were also analyzed in combination with the other flood management measures.

73. In addition to the small, medium and large size channel improvements, a smaller size improvement with riprap lining was also studied. The NED Plan of improvement on Cape La Croix Creek would consist of a 75 foot wide rectangular concrete channel from mile 2.76 to 3.14 and a 40 foot wide trapezoidal riprap lined channel from mile 3.23 to 3.76 with appropriate transitions sections at the downstream and upstream ends of the improvement. Channel sections above mile 3.80 and below 2.72 were found to be economically infeasible.

74. Walker Branch Channel features consist of a 60 foot wide concrete rectangular channel extending from the mouth to Independence Street located at mile 0.40 and a 50 foot wide segment from Independence Street to Kingsway Street at mile 0.89. Beginning at mile 0-.96 to mile 1.68 is a 75 foot wide trapezoidal grass-lined channels have 3 horizontal to 1 vertical side slopes. A riprap transition section runs from mile 1.68 to 1.74 where a creek intersects. A 35 foot wide grass-lined trapozoidal channel begins at mile 1.74 and extends to mile 2.00 where channel improvements end.

75. Bridge replacements were included as part of the channel improvements. On Walker Branch bridges considered for replacement include Good Hope Street, William Street, Town Plaza Drive, Independence Street, Themis Street, Private Drive, Bessie Street and Marietta Street. One bridge at Independence crossing Cape La Croix Creek is undersized and it is scheduled for construction within the year.

NONSTRUCTURAL MEASURES

76. Nonstructural features considered in formulating plans included the removal of floodprone structures, floodproofing, elevating structures, low floodwalls or levees, flood hazard warning and floodplain zoning.

OTHER MANAGEMENT MEASURES

77. Other flood control features which were considered include levees, floodwalls and diversions. Because of the severe encroachment upon the streams and the numerous crossings in the commercial and residential areas, levees and floodwalls were not considered to be feasible alternatives. Also, a feasible flow diversion alternative would not be established.

COMBINATIONS

78. Those measures which appeared to be viable flood control measures were used as a basis to create the NED, EQ, SPF, Plan "A", and Recommended Plans plus the Nonstructural Plan.

79. A brief summary of each of the six final alternatives follows:

NATIONAL ECONOMIC DEVELOPMENT (NED) PLAN

80. The NED plan was developed by dividing flood control features into separable economic and hydraulic elements. Each element was then selected on its ability to maximize net tangible benefits. Additionally, the planning constraints required that the final array of alternatives, including the NED plan, be implementable plans.

81. Of the flood control features evaluated in earlier studies the one which best maximized net benefits was selected as the basis for the NED alternative. This feature was the dry detention reservoir at site 1, with the capacity to store a 10-year storm before overtopping the spillway. Additional analyses were performed to determine more accurately the channel improvement elements which when added to the dry detention reservoir, would best maximize net benefits. In addition to the small, medium and large size channel improvements, a smaller size improvement with riprap lining was also studied. The hydrologic and hydraulic models were used to compute discharge hydrographs and water surface profiles for each channel improvement system on Cape La Croix Creek and Walker Branch for the full range of recurrence intervals. Average annual benefits and costs were computed for each alternative. The results indicated that the alternative which best maximized net benefits was the combination of a dry detention reservoir on Cape La Croix Creek and channel improvements on Cape La Croix Creek and Walker Branch. The flood control features in this plan were selected for the NED plan improvement. On Cape La Croix Creek, the channel features consist of a 75 feet wide rectangular concrete channel from mile 2.76 to 3.14 and a 40 feet wide trapezoidal riprap lined channel from mile 3.23 to 3.76 with appropriate transition sections at the downstream and upstream ends of the improvement and at the change in channel section. Channel improvements for the segments below 2.72 and above 3.80 were found to be economically infeasible. On Walker Branch, the channel improvement features consist of a rectangular concrete channel 60 feet wide between the mouth and Independence Street (mile 0.40) and 50 feet wide from there to Kingsway Street (mile 0.89). Also, included is a trapezoidal grass-lined channel 75 feet wide between miles 0.96 and 1.68, and 35 feet wide between miles 1.74 and 2.00. Appropriate transition sections connect the various channel improvement segments. Several bridge replacements were included as part of the channel improvement features. Recreational features which had net benefits were added to these flood control measures and included in the NED Plan.

PLAN "A"

82. In order to present a wider array of alternatives, a plan which provided for greater flood protection was selected. This plan was named Plan "A" and was carried to the final array of plans. Plan "A" consists of a dry detention reservoir, channel improvements on Cape La Croix Creek and Walker Branch, relocation of two low-lying residential areas and selected environmental and recreational facilities. The dry detention reservoir is the same as the NED dry detention reservoir at Site 1. Channel improvements on Cape La Croix Creek include a 75 feet wide rectangular concrete channel from mile 2.76 to 3.76, and a grass-lined trapezoidal channel with a bottom width of 110 feet and side slopes of 3:1 from mile 3.80 to 5.11 with appropriate transition parts. Channel improvements on Walker Branch consist of a 60 teet wide rectangular concrete channel from 0.00 to 0.40, a 50 feet wide rectangular concrete channel from mile 0.40 to 0.89, a trapezoidal grass-lined channel, with a bottom width of 75 feet and side slopes of 3:1 from mile 0.96 to 1.68, and a trapezoidal grass-lined channel with a bottom width of 35 feet and side slopes of 3:1 from mile 1.74 to 2.00. Appropriate transitional segments connect the various channel improvement sections. As in the NED plan, several bridges were replaced along Walker Branch. Since substantial damages would still be sustained by the low lying residential areas along Sprigg Street near mile 0.40 of Cape La Croix Creek and the Golliday Subdivision near mile 0.90 of Walker Branch, Plan A included the relocation of the residents and razing of the structures. Environmental and recreational features, described elsewhere in this report were added to Plan "A". Since many of the flood control features are identical to the NED plan, the effect of this plan on the discharge-frequency relationship was very similar to that of the NED plan. However, due to the increased channel carrying capacity of Cape La Croix Creek water surface profiles were further reduced in this plan.

ENVIRONMENTAL QUALITY (EQ) PLAN

83. Plan "A" was selected as the Flood Control Base for the EQ Plan in an effort to develop an implementable plan which would accomplish the major goal of flood control while maximizing environmental benefits. Since the EQ Plan consists of the same flood control features as Plan "A" plus environmental and recreational features which would have no significant effect on flood discharges or profiles, the hydrographs, discharge frequency curves and water surface profiles for Plan "A" would also apply to the EQ Plan.

84. Hopper Road Park. Under the EQ Plan the purchase of this 86-acre bottomland tract would prevent the establishment of future urban development within this area. This would protect the area's natural flood storage capability; thus, some reduction in building damages would be expected.

85. The purchase of this tract bottomland would prevent future development that could add to increased runoff and increased flood heights downstream. As mentioned previously, bottomland forest represents a very productive but limited wildlife habitat resource; its preservation is therefore important. The Hopper Road tract also provides the advantage of being readily accessible to the urban public for non-consumptive wildlife enjoyment. Existing interest in such activity is already evidenced by the presence of dirt trails at the lower end of the site near the Hawthorne School.

86. Meander Site Park. Implementing the EQ Plan would curtail total development for the section of Cape La Croix Creek downstream of the Meander site. In view of this, the park could provide at least some potential for flood storage and damage reduction. The bottomland could help reduce downstream water velocities and erosion, and could provide at least some natural flood storage capacity and groundwater improvement. Purchase of the area would preclude development that could contribute to increased runoff and increased flood heights downstream. This area's soil type qualifies as prime farmland though the area is not now nor is it expected to be cultivated. The present natural land use of the area would be preserved by this project feature. The habitat of this area consists of one-half bottomland forest, and one-half open land. There are 2 small cutoff meanders at this site.

87. Without a project it is expected that this tract will be filled for development. The fact that similar meanders and forest were recently changed to this land use along the opposite creek bank would tend to support this conclusion. Subtracting recreational development, about 60 percent of this site would be left as undeveloped habitat. This measure can be combined with the wildlife management measure and provide much opportunity for the enjoyment of wildlife. Wildlife species, especially those well suited to an urban setting, would benefit from the park area.

88. Riffle and Pool Forming Structures. These structures would be used in conjunction with proposed channelization work between Cape La Croix Creek miles 3.8 and 5.10. While such structures would be beneficial to groundwater recharge during periods of low flow, the formation of pools would be expected to cause some deposition of sediment and debris. Past flood control actions have resulted in a creek with few logs, or snags, and a uniform depth that provides few pool and riffle sections necessary for the production of fish foods and spawning areas. No major change from this condition is expected for a future without a project. The placement of a check dam at river mile 4.2 could help restore needed variety to the aquatic habitat, by creating or deepening pools. An improved habitat is expected to result in an increased production of fish and other aquatic organisms.

89. Fish Pond Improvements. Two farm ponds are located near the detention site and are being adversely impacted by the siltation effects of agricultural run-off. It has been estimated that farm ponds in crop land areas have a life of only 25 years. Under this measure, the ponds would be evaluated to determine their habitat value, and if necessary, deepened to enhance aquatic life. The drainage areas adjacent to the ponds would be planted with vegetation suitable for the reduction of siltation and subsequent extnesion of pond life.

90. An EQ corridor, in combination with recreational trails, would provide a unique opportunity for the enjoyment of non-game wildlife species. Loss of vegetation may cause temperature increases in the creek and along its banks, making it impossible for present species having lower temperature needs to continue to inhabit the creek. The increased vegetation established as part of the project plan is considered to be an improvement over the future without conditions and may reduce some of the adverse aquatic impacts associated with development.

NONSTRUCTURAL PLAN

91. The nonstructural plan of removing the structures damaged by the flood with a 10 percent chance of occurrence was carried forward from the Stage 2. This flood was selected as the minimum desired degree of protection. Other nonstructural alternatives such as flood proofing, raising of structures, low flood walls or levees and zoning were considered Stage 3. Due to the depth and rapidity of flooding, the type of construction and access required for the many commercial establishments, the most feasible alternative appeared to be the removal of 123 commercial and 131 residences. However, the nonstructural plan was not economically justified and was unacceptable to local interests due to the large number of economic enterprises and residences that would be affected. Plans with a greater degree of protection would force the relocation of even more structures. However, for some sites, the acquisition and razing of structures and relocation of residents was found to be a feasible solution and was incorporated in other plans.

THE STANDARD PROJECT FLOOD (SPF) PLAN

92. Plan 9, consisting of the largest practical channel improvements on Cape La Croix Creek and Walker Branch plus the largest dry detention reservoir at Site 1, was carried forward from Stage 2. To these features was added the dry detention reservoir at Site 2, capable of storing the flood with a 0.2 percent chance of occurrence. This plan resulted in the best overall degree of protection with about a 97 percent reduction in total damages, but fell short of SPF protection. The plan was not economically feasible nor was it acceptable to local interests due to the large number of building relocations and bridge replacements required.

RECOMMENDED PLAN FEATURES

93. The Recommended Plan consists of the flood control and recreation features of the NED Plan, plus nonstructural measures and additional recreational features.

RECOMMENDED DRY DETENTION RESERVOIR

94. The recommended dry detention reservoir is designed to store the runoff from a storm with a 10 percent chance of occurrence before overflowing the spillway. The spillway crest is designed to be a broad-crested weir 100 feet wide at elevation 430.5 with a "C" value of 2.7. The spillway is designed to pass the Probable Maximum Flood, assuming that it occurs five days after the Standard Project Flood, without overtopping the dam. The top of dam is set at elevation 446.3, four feet above the maximum water surface elevation of the pool. The 54 inch CMP low level outlet which will allow the reservoir to drain, has its invert at elevation 405.0. The concrete lined spillway chute and stilling basin with 19 baffle piers is designed for a Type III basin in accordance with the Bureau of Reclamation Publication, "Hydraulic Design of Stilling Basins and Energy Dissipators." The stilling basin is 48.5 feet long with a riprap lined transition that extends 330 feet downstream from the end sill of the stilling basin.

RECOMMENDED CHANNEL IMPROVEMENTS

95. The recommended channel improvement on Cape La Croix Creek consists of a rectangular concrete channel, 75 feet wide extending from mile 2.76 to 3.14 and a trapezoidal riprap lined channel from mile 3.23 to 3.76. The trapezoidal channel has a bottom width of 40 feet and side slopes of 1 vertical to 2.5 horizontal. Riprap sizes were designed to withstand velocities for the one percent chance flood using WES Hydraulic Design Criteria, Volume 2, published by the Waterways Experiment Station, Vicksburg, Mississippi. A concrete lined transition is required at the downstream end of the concrete channel (mile 2.72 - 2.76), and a riprap lined transition is required at the upstream (mile 3.76 - 3.80) end of the riprap channel, and from mile 3.14 to 3.23 where the channel section changes from a rectangular to a trapezoidal section. Transitions for all channel improvements were designed as a wedge type transition using EM 1110-2-1601, Appendix III. No channel improvements are planned for the reach below mile 2.72 or above mile 3.80. The bridge at Independence Street would be replaced with a clear span by the City of Cape Girardeau. On Walker Branch, the concrete channel improvement extends from the mouth up to Kingsway Street at mile 0.89. The channel width is 60 feet between the mouth and Independence Street at mile 0. 0, and 50 feet between Independence and Kingsway Streets. A grass-lined trapezoidal channel with a bottom width of 75 feet and 1 vertical to 3 horizontal side slopes, extends from mile 0.96 up to mile 1.68. From mile 1.74 to Perryville Road at mile 2.00, the recommended grass-lined

channel has a bottom width of 35 feet with side slopes of 1 vertical to 3 horizontal. A concrete lined transition is required from mile 0.89 to 0.96 to change the channel section from rectangular to trapezoidal. A riprap lined transition is used to connect the two trapezoidal channels between miles 1.68 and 1.74. Bridge replacements required by the improvement include Good Hope Street, William Street, Town Plaza driveway, Independence Street, Themis Street, Private Driveway, Bessie Street and Marietta Street. Riprapped transitions are required at the Missouri Pacific Railroad, Broadway Street, Kingsway Street, Lombardo Street and Perryville Road. Mannings roughness coefficients used in the Recommended Plan model were 0.015 for concrete, 0.035 for riprap and 0.030 for grass-lined channels Overbank roughness coefficients varied between 0.020 and 0.090.

RECOMMENDED NONSTRUCTURAL MEASURES

96. The recommended nonstructural measures include the relocation of residents and razing of the 37 structures near Sprigg Street along Cape La Croix Creek and of 18 residences at the Golliday Addition on Walker Branch. These two sites will be developed into small parks.

RECOMMENDED RECREATIONAL FEATURES

97. This plan provides for hiking and biking trails, recreation features at Golliday, Sprigg, Bessie, and the dry detention reservoir. (See APPENDIX F.)

IMPACT ASSESSEMENT AND EVALUATION OF FINAL ALTERNATIVES (TASK 3 and TASK 4)

98. For this final formulation cycle, the impact assessment and evaluation focused on three of the final alternative. Because of the unreasonably high costs of the SPF and nonstructural plans these plans were not considered further. Impact assessment was organized to cover economic, social, and environmental effects. This assessment and evaluation is discussed under the topics of environmental, social well-being, economic, and hydrologic performance.

99. <u>ENVIRONMENTAL IMPACT ASSESSMENT</u>. The relationship between each of the project plans and their component management measures is shown in TABLE B-1. Unless otherwise indicated in the following discussion, the impacts of each measure are nearly identical for each plan containing such measures.

100. <u>Concrete Channels</u>. The construction of concrete channels provide significant flood protection. In combination with grass channels substantial damage reductions occur.

101. New concrete channels will require energy to construct, however, substantial energy savings result from damages prevented thru the prevention of flood related property repairs.

102. The construction of concrete channels would largely eliminate the aquatic community within these affected reaches. During periods of low water levels low both upstream and downstream movement of aquatic organisms could be prevented. As such, the construction of concrete channels is considered to adversely impact the stream community in those reaches so constructed.

103. Earthen Channels. The flood protection, energy consumption, impact of land utilization, and air pollution impacts would be the same as those described for the concrete channel measure. Due to the flatter side slopes and grass lining of the earthen channel, bank erosion would be reduced. Sheet erosion and gully erosion in the surrounding landscape would not be affected. Earthen channel impacts on water quality would be more similar to natural channels than to those indicated for concrete channels.

104. Residential development is the main land use type found next to the proposed earthen channel sections. Woody cover along the banks in these areas is presently at 50 percent. With the project, the right-of-way on each bank would probably have vegetative cover restored. Overall, the measure's impacts to vegetation and terrestrial organisms are perceived as minor. Tree removal and bottom disturbance associated with stream channelization will have a moderate impact on aquatic life during construction. It is expected that most species within the channelization sections will be destroyed; however, it should be noted that this area has already been damaged by past flood control efforts. These past measures have included the removal of vegetation, drag-line excavation, and channel straightening.

105. The kinds of fish species to be impacted by channelization in the lower portion of Cape La Croix Creek are largely from groups that are fairly pollution tolerant and are less susceptible to habitat disturbance as a result of flooding or human activities. Those species to be impacted in Walker Branch are more sensitive to habitat changes and will be more severely impacted. Aquatic species would be expected to recolonize the stream when the new channel has stabilized, and as the food chain and water temperatures are restored. Stream recovery times are highly variable, but it is expected that habitat improvement measures such as pool forming devices would accelerate recovery. The cultural resources field survey indicated one archaeological site to be located directly within the proposed channel area. Future urbanization may adversely impact this site.

106. Dry Detention Reservoir. Downstream flooding would be reduced by the construction of a detention reservoir. When added to the dry detention reservoir the channelization features reduce property damages to 85 percent under the Recommended Plan, 84 percent in the NED plan, and 92 percent under the EQ plan. Construction of this reservoir would require the removal of one farm property.

107. Energy savings connected with reduced property expenditures should be far greater than the fuel consumption costs for building the reservoir. Without a project the prime farmland within the reservoir region could become residentially developed. With the project, farming could continue. However, the lower half of the area being impacted by a greater amount of flooding would be better suited for hay rather than row crop production. Some ten acres of prime farmland would be permanently lost as a result of construction work. Construction related noise and air quality impacts will be low since there would be relatively few homes in this area at the time of construction.

TABLE B-1
CAPE LA CROIX CREEK AND WALKER BRANCH
RELATIONSHIP OF PROJECT MANAGEMENT MEASURES TO THE FINAL PROJECT PLAN

	Recommended Plan	NED Plan	EQ Plan
Concrete Channel	X	X	X
Earthen Channel	X	X	X
Detention Reservoir	X	X	X
Bridges	X	X	X
Building Displacements	X	X	X
Trails	X	X	X
Hopper Road Park	-	-	X
Meander Park	-	-	X
Wildlife Management	-	-	X
Urban Wildlife Program	-	-	X
Wetlands Preservation	-	-	X
Endangered Species	-	-	X
Aquatic Habitat Structures	-	-	X
Fish Pond Improvements	-	-	X
Water Quality Strategies	-	-	X
Trash Removal	X	X	X
Cultural Resource Management	-	-	X
One Bank Channel Construction	X	X	X
Riparian Corridor	-	-	X
Detention Park	X	X	X

108. The project impacts on water-resources would be beneficial. Erosion would be reduced as a result of decreased water flow within the channel, and the reservoir's water storage ability would reduce downstream flooding. The local water supply would be somewhat improved by an increase in the time available for water to percolate into the ground. Flooding within the reservoir itself can cause potentially harmful impacts on vegetation. These include decreased plant growth, death of root systems, a reduction of plant and reproductive processes. Such effects vary with plant type, soil, and flooding frequency. Flooding that occurs during the plant's growing season has the greatest potential adverse impact.

109. A review of the model data developed during the present study, and a review of plant flood survival information, indicates that no major changes in the existing vegetation of the reservoir would be expected.

110. It is possible that a slight but gradual species composition shift would occur as a result of a new dam. However, provided that the discharge pipe remains totally functional, the reservoir's flooding should be of short duration and having minor impact on most of the natural vegetation. Annual flooding of short duration, such as that likely for detention site, is expected to have only a temporary effect on the fauna.

111. The dry detention reservoir would allow normal water flows during non-storm periods, and is thus not expected to alter stream conditions above or below the impoundment structure. Short-term impoundment of water during storm events is not expected to impact aquatic life beyond what would be expected during normal flood conditions. As such this plan is not expected to adversely impact the aquatic ecosystem. The cultural resource survey identified one historic and 4 prehistoric sites within the dry detention basin. Pasture covers part of the historic sites making these sites difficult to visualize during the field work. Some sites may remain unidentified. During the detailed design phase of the project, five known cultural properties will be evaluated for their importance.

112. Bridge Removals/Replacements. Because of their small openings, certain bridges now restrict water flow during high water stages. The resulting buildup of water behind these bridges contributes to flood damages. Bridge or replacement removal or with larger structures, would help reduce the flooding problem. Moderate levels of dust, fumes, and noise are expected during the construction work. Erosion around bridges would be reduced if smaller structures are removed or replaced with larger ones. The deposit of sediment and debris above the bridges would also be reduced.

113. Building Displacements. Building displacement would eliminate flood damages to all those structures so removed. This would include 67 structures for the Recommended Plan, 67 for the EQ plan, and 12 for the NED plan. There would be energy savings resulting from reduced flooding

damage and its associated energy requirement for repairs. This savings should be greater than that amount of energy used in removing the structures.

114. Trails. A small acreage of undeveloped land would be lost by the placement of trails along the creek and within parks. The wildlife habitat loss would be minor. On the positive side, these trails provide access to the creek's habitat for birdwatching, wildlife photography, and for just general wildlife observation.

115. A cultural resource survey failed to show the presence of any archaeological remains in this area. Should this measure become part of the final project plan, additional cultural resource surveys could be conducted.

116. Wildlife Management. By allowing many of the steeper pasture covered hill slopes of the detention park to become reforested, moderate improvement in soil conservation would be expected. The soil type found on these slopes is well suited for woodland vegetation, and provides good wildlife habitat. Other areas of the project would likewise benefit from increased woody cover. With an increase in woodland there would be reduced water runoff to contribute to flooding and also a slightly improved groundwater supply. The woodland cover would also decrease erosion and thus improve water quality. Most importantly, this management measure would greatly enhance the availability of food and cover necessary for the human recreational enjoyment of wildlife. TABLE B-2 indicates the value added to some 11,500 homes should a backyard wildlife program be implemented by the local sector.

117. Minor noise and dust reduction would result from the increased woody cover. An increase in tree and shrub species would induce a similar increase in the abundance and diversity of wildlife species due to increases in food and cover. Such a change would greatly enhance the opportunity for people to view wildlife wherever vegetative improvements occur.

TABLE B-2
CAPE LA CROIX CREEK AND WALKER BRANCH
POTENTIAL BENEFIT/COST RELATIONSHIP FOR
CAPE GIRARDEAU BACKYARD WILDLIFE PROGRAM
IMPLEMENTED BY LOCAL SECTOR

Management Goal Goal (% Cover)	No. of Existing Houses	Value Added (%)	Value Added ($)	Cost $	BCR
65	11,500	1.7	8,800,00	3,450,00	2.6

Assumptions:

- The present and future median property value without a project would be $45,000.

- The tree cover without a project would be 50 percent of existing conditions.

- The maximum value added to a property would be 7.5 percent for an area converted from no trees to one with 65 percent tree cover; thus, proportionally an making a 15 percent cover shift would yield an increase in added property value of 1.7 percent.

- Cost per household to develop yard would be $300.

118. Wetlands Preservation. The measure would be beneficial, by reducing water velocities and erosion, by protecting a natural flood storage area, and by contributing to local groundwater supply. Within the near future, it is expected that urbanization will result in the total elimination of nearly all wetlands. These wetlands represent a distinct ecosystem being composed of a rather unique fauna and flora. This preservation measure provides more opportunity for contributing positive biological benefits to the area than any other single program.

119. Endangered Species. Two Federally listed endangered species, the bald eagle and peregrine falcon, can occasionally occur in the Cape Girardeau area. Based on present information, however, neither of these two species or their critical habitats will be impacted by the project.

120. Support for Federal and State Clean Water Efforts. Based on the water quality criteria set forth by criteria state and Federal agencies, the water quality of the study area is considered to be acceptable. Because of agency regulations, water quality in the future is expected to

improve over that of the existing conditions. Project and local support for the water quality improvement efforts of other agencies could have a positive impact on aquatic organisms. Improvements in the food chain, numbers of species, and their abundance would be anticipated. Agency efforts to control the use of septic systems would appear to be an especially important factor. The geology of the watershed permits surface water to penetrate rapidly into the groundwater system. Little water cleansing time occurs, leaving the groundwater easily subject to the effects of pollution.

121. Trash Removal. Periodic trash removal campaigns would improve water quality and also enhance the habitat for aquatic organisms. Bank erosion and swellheads near bridges would be reduced.

122. Cultural Site Preservation. All sites identified during the field surveys are in private ownership, and as such are subject to impacts from a variety of land use patterns. Without Federal involvement, these sites are likely to be lost. Urbanization is the most serious threat because it usually involves ground surface changes that result in the total destruction of the archaeological resource. Prior to construction, all sites located within proposed impact areas would be evaluated for significance in a manner consistent with the National Historic Preservation Act.

123. One Bank Channel Construction. According to a U.S. Forest Service (USFS) Study trees can contribute about 7 percent to the total value of residential properties. Much of the mature tree vegetation along the Walker Creek is adjacent to such properties and it is expected that a monetary benefit would result from leaving these trees intact on one bank.

124. The shading and wind protection provided by leaving bank vegetation intact would contribute to a reduced home energy use. The creek by being left in a more natural state would be more aesthetically pleasing. Dust and noise reduction, and some food and cover value for terrestrial and aquatic organisms would also result from this measure.

125. Riparian Corridor. Trees used as windbreaks can reduce winter fuel consumption and by their shading can also effect home energy use by reducing summer cooling costs. Some reduction in dust and noise levels will result. The preferred land use of soil at a creek's edge would be as woodland. Here it is not only very useful to wildlife but helps to reduce bank erosion and losses of farmland next to the creek. Soil in this area is also subject to flooding and is therefore not suitable for urban development. The importance of creekside vegetation to water quality is well known in forestry management and in agricultural watersheds. When vegetation is maintained, it improves water quality during water runoff by causing sediments to deposit away from the creek and by reducing bank scour.

126. Detention Park Site. The chief contribution of the park site to soils is relative to its potential for being combined with the wildlife management measure. One component of the management feature would be to increase the extent of forested cover along the steeper more erosive prone slopes. In combination with the wildlife management measure, potential exists for increasing forest cover. Forest cover reduces surface runoff and this in turn results in decreased soil erosion and improvements in water quality. Forested areas also improve water infiltration, and thus contribute to groundwater availability.

127. The park lands would in time provide suitable habitat in an otherwise developed urban setting. As such, it would afford a moderate benefit to urbanites looking for an opportunity to view wildlife close to home. The parks more natural state would be expected to support a higher diversity and abundance of terrestrial species than residents would normally be expected to find in backyard settings. Enhancement of the park's habitat through the wildlife management measure would further benefit wildlife, and recreational experiences.

128. Three archaeological properties were located within the affected area during the 1982 field survey of the detention site. It will be possible to design the project such that these properties are left undisturbed.

129. SOCIAL WELL-BEING EVALUATION. The evaluation of the various alternative solutions from a social well-being viewpoint was based on estimating relative impact on 14 different factors. These factors evaluated are: noise; homes displaced; aesthetic values; housing quality; archaeological; historic; transportation; education; leisure; cultural values; community cohesion; regional growth; institutional; and, finally, health, safety and welfare. The social well-being evaluation of 14 factors indicated no impacts of severe enough effect to preclude implementation of any of the final array of alternatives. The need for flood protection was the driving social well-being concern. Detailed tabulation of these results are available from the St. Louis District Corps of Engineers.

130. ECONOMIC EVALUATION. The evaluation of the various alternative solutions from an economic impact viewpoint is summarized in the following paragraphs.

131. Tax Revenue. Column (1) of TABLE B-3 presents data for gains in tax revenue attributable to the implementation of each alternative. They are values which indicate tax revenues raised as a result of the construction of each plan and its regional multiplier effect. The values were developed in the following way:

a. The August 1983 issue of the Survey of Current Business reports that the 1983 year-to-date average weekly earnings per contract construction worker at $450, or $23,400 per year.

b. In addition, the 1978 issue of Monthly Labor Review (Vol. 101, No. 10) indicates that 38.2 hours of labor are generated for each $1,000 of contract construction for civil works projects (local flood protection-land projects).

c. Using this information, the following information was generated:

Plan	Estimated First Cost	Man-Days of Work Generated	Man-Years of Work Generated	Worker Income Generated
REC	$25,900,000	123,700	339	$7,932,600
NED	24,100,000	115,100	316	7,394,400
EQ	33,300,000	182,900	502	11,746,800
SPF	59,000,000	281,700	773	18,088,200
NSTR	57,300,000	273,600	749	17,526,600
PLAN "A"	34,100,000	162,800	447	10,459,800

d. Using the regional multiplier for OBERS BEA area 115 of 2.764, primary and secondary incomes generated were developed:

Plan	Worker Income Generated	Multiplier	Total Revenue Generated
REC	$ 7,932,600	2.764	$21,925,700
NED	7,394,400	2.764	20,438,100
EQ	11,746,800	2.764	32,468,200
SPF	18,088,200	2.764	49,995,800
NSTR	17,526,600	2.764	48,443,500
PLAN "A"	10,459,800	2.764	28,910,900

e. Out of a $.04 sales tax for each dollar spent by the workers, an estimated $.01 cent goes to local taxes yielding the following local government revenue increases.

Plan	Tax Revenue Generated
REC	$219,300
NED	204,400
EQ	324,700
SPF	500,000
NSTR	484,400
PLAN "A"	289,100

TABLE B-3
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 REGIONAL DEVELOPMENT DATA

PLAN	(1) TAX REV.	(2) PROPERTY VALUES $	(3) PUBLIC FACILITIES
REC	$219,300	I	94.8
NED	204,400	I	58.2
EQ	324,700	I	159.1
SPF	500,000	I	0
NSTR	484,400		0
PLAN "A"	289,100		0

	(4) PUBLIC SERVICES	(5) MAN-YEARS OF EMPL.	(6) BUS ACT. ($1,000,000)	(7) DISPLACED FARMS
REC	94.8	339	21.9	1
NED	58.2	316	20.4	1
EQ	159.1	502	32.5	1
SPF	0	773	50.0	1
NSTR	0	749	48.4	1
PLAN "A"		447	28.9	

132. Property Values. It has been reported in communities that have been studied that there is a difference in housing values off and on a floodplain. However, a limited number of communities have been studied, and they have been residential, rather than commercial, in character. For purposes of this study, since the major damage centers are predominantly commercial, it will be assumed that a reduction in average annual damages will have a positive effect on property value, but an attempt to quantify this effect will not be made. An increase will be designated by an "I" in Column 2, TABLE B-3.

133. Employment. The values for employment came from the analysis conducted earlier under Tax Revenues. Column (5), TABLE 3 summarizes the results.

134. Business Activity. The values for business activity in Column (6), TABLE 3 also came from work done in the Tax Revenues category. Business revenues included the values of the business or sales created from direct Federal first cost, as well as the ensuing multiplier effects throughout the region.

135. Displaced Farms. As indicated in Column (7), TABLE 3, there is one displaced farm associated with the Recommended, NED, and EQ Plans.

136. HYDROLOGIC PERFORMANCE. The hydrologic performance is discussed under the topics of hydrologic impacts, flood profiles and flows, past floods and sediment and scour in the following paragraphs:

a. Hydrologic Impacts. The Recommended Plan provides a high degree of protection from flooding utilizing both structural and nonstructural measures, provides for recreation, and is economically feasible. The structural flood control features for the NED and Recommended Plans are the same as those for the Recommended Plan.

b. Flood Profiles and Flows. Peak flows in Cape La Croix Creek at Hopper Road are reduced considerably due to the storage effect of the dry detention reservoir. On Walker Branch at Bessie Street, flows with the recommended channel improvements are slightly higher than with no improvement. At the mouth of Walker Branch, the less frequent flows with the Recommended Plan are considerably greater than those with no project. However, these hydrograph plots do not account for the diversion of flow from Cape La Croix Creek to Walker Branch at Independence Street. Because of the reduced flows and greater channel capacities on Cape La Croix Creek, much less flow is diverted with the Recommended Plan. The net effect at the mouth of Walker Branch is that flows are slightly reduced with the Recommended Plan. The discharge frequency curves show the effect of the Recommended Plan on peak flow values which take into account the diversion of 40 percent of the left overbank flow on Cape La Croix Creek to Walker Branch at Independence Street. At the mouth of Cape La Croix Creek, the less frequent flows are somewhat reduced with the Recommended Plan, but the effect becomes less

for the more frequent flows. Sensitivity tests were conducted on Mannings roughness coefficients used in the Recommended Plan model. Profiles were computed assuming 80 percent and 120 percent of the roughness coefficient values used. The resulting profiles were then used to compute flood damages. It was found that a reduction of 20 percent in roughness coefficient resulted in a raise in the water surface profile by less than a foot. The consequence of given discharges flooding to greater than expected depths would result in a somewhat lower degree of protection for residents and businesses in the floodplain. However, since there are no levees or floodwalls included in the Recommended Plan, no potential catastrophy would occur due to the project design being exceeded. Also, since the Cape La Croix-Walker basin is well defined, flow over drainage divides will not occur even if water surface profiles are estimated much too low. Sensitivity tests were not performed for expansion and contraction coefficients used in this study. However, such tests were conducted for the Maline Creek urban study recently completed by the St. Louis District. Those tests showed that variations in the coefficients had little effect on average annual damages. Since similar values were used n this study, the same result could logically be expected for the Cape La Croix Creek basin. One factor which was not considered is debris accumulation, which is difficult to predict. However, since in the Recommended Plan, eight small bridges or culverts on Walker Branch and one on Cape La Croix Creek were assumed replaced with clear spans, the likelihood of debris accumulation at bridges would be reduced with the project.

c. Past Floods. One of the more frequent questions asked by local residents was "How will this Recommended Plan affect a flood like those we have experienced in the past?" Therefore, the discharges for the May 1973 and March 1977 floods were computed using the recorded rainfalls, assuming the Recommended Plan in place. These discharges were input in the HEC-2 model for the Recommended Plan and water surface profiles were computed for each of the floods. The profiles show that water surface elevations would be lowered considerably through the commercial and residential reaches of Cape La Croix Creek and Walker Branch with the Recommended Plan in place.

d. Sediment and Scour. Upper reaches of Cape La Croix Creek and Walker Branch appear to be fairly stable at the present time, without much evidence of significant erosion or deposition. The headwaters of Cape La Croix Creek are located in the steep hills north of Cape Girardeau. These hills are mostly wooded or open pasture land with only scattered residential or agricultural development. The channel between Highway 61 at mile 6.1 and the northern city limits of mile 8.45 has a gravelly bottom with some rock outcrops, and shows very little erosion although the channel slope is very steep, about 18 feet per mile. Channel velocities in this upper reach vary between 3 and 9 feet per second for future conditions without a project. Since no channel improvements are recommended for this reach, no significant change in velocity is anticipated as a result of the Recommended Plan. The channel

AD-A141 579 WATER RESOURCES INVESTIGATION CAPE GIRARDEAU - JACKSON METROPOLITAN AREA MISSOURI VOLUME 2 APPENDICES(U) ARMY ENGINEER DISTRICT ST LOUIS MO DEC 83 2/4

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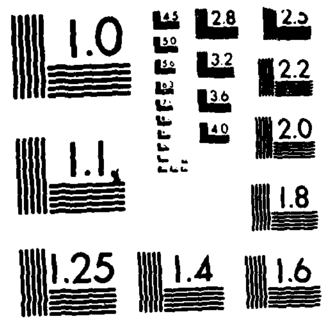

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

slope between the north Highway 61 crossing and Bloomfield flood is about 8 feet per mile. This reach includes most of the recommended channel improvements on Cape La Croix Creek. Channel velocities in this reach vary between 2.5 and 7 feet per second for future conditions without a project but may exceed these values at bridges. Channel velocities with the Recommended Plan vary from 1.5 to 4 feet per second in the grass-lined reach and from 3 to 9 feet per second in the concrete lined reach of improved channels. Because of the flatter invert slope and enlarged cross section of the improved grass-lined earth channel, some deposition may be expected to occur between Highway 61 and Arena Park. However, a slight channel enlargement completed by the city in the mid 1970's between Hopper Road and East Rodney Street has apparently not caused any significant deposition problem. Below Bloomfield Road, Cape La Croix Creek has a somewhat flatter slope of 5.5 feet per mile. The channel was straightened and enlarged between miles 2.4 and 2.9 in the early 1970's, cutting off a large meander. Then in the late 1970's, the lower three miles of the channel were cleared of debris and vegetation. Since there are no channel improvements recommended below mile 2.76, some continued channel maintenance may be necessary in the downstream reach. Channel velocities in this reach with the Recommended Plan vary between 2 and 6 feet per second. No serious erosion problems are evident in the Walker Branch basin. Some deposition of sediment has been observed at the Lombardo and Broadway Street crossings, but appear to be local problems and not widespread. Sediments may have been a result of construction activity in the upper part of the basin which is undergoing residential development. Because the recommended grass-lined channel has a wider cross section, some deposition of materials may be expected between miles .89 and 2.00. Channel velocities in this reach can be expected to be between 2 and 6 feet per second with the Recommended Plan. In the concrete lined improved channel, velocities vary from 3 to 8 feet per second. In an attempt to assess the sensitivity of the water surface profiles due to possible deposition in the channel, the hydraulic model for the Recommended Plan was modified to simulate an accumulation of 2 feet in the channel between Hopper Road at mile 5.11 and East Rodney Street at mile 4.09 and from the downstream end of the concrete channel at mile 2.76 to Wilson Road at mile 1.85. It was found that the profiles for the rare events were raised only slightly, less than 1 foot but for the more frequent, in-bank events, profiles were raised up to 2 feet in both reaches. With proper maintenance, erosion or deposition should not prove to be a significant problem. However, the erosion and sedimentation characteristics of the selected plan should be thoroughly analyzed in the post-authorization design memoranda.

137. CONCLUSION OF STAGE 3 STUDIES. The Stage 3 studies iterated the four planning tasks (problem/opportunity identification, formulation of alternatives, impact assessment, and evaluation) at a level of detail that successfully screened out management measures and comprehensive alternative solutions.

138. The system of accounts is the most convenient comprehensive summary available to display the no action, Recommended, NED, and EQ plan impacts. As previously noted, the designated SPF and nonstructural plans were eliminated as potential plans for recommendation, based upon economic performance. The system of accounts analysis for Stage 3 final considerations follows in TABLE B-4 for the Recommended, NED, and EQ plan impacts. Costs and benefits for the Stage 3 studies are presented in APPENDICES E and G.

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 1
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	NO ACTION PLAN		
	LOCATION OF IMPACTS		
ACCOUNTS	Study Area	Region	Rest of Nation
1. National Economic Development			
a. Beneficial Impacts			
(1) Value of Increased Outputs of Goods and Services			
(a) Flood Damage Reduction	None	Growth of national flood losses gradually reduced in future	Positive, not quantified
(b) Land Enhancement	None	None	None
(c) Recreation/ Environmental	Long range conversion of abandoned space to green space	Insignificant	Positive, not quantified
(2) Value of Increased Output Resulting from External Economies	Not evaluated	Not evaluated	Not evaluated
(3) Value of Output from Use of Unemployed or Underemployed Labor Resources (NED Employment)	None	None	None

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 2
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	NO ACTION PLAN LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(4) Total Beneficial Effects	Positive	Positive	Positive, not quantified
b. Adverse Impacts			
(1) Project Costs - Flood Damage	$4,126,100 AA Damages	$4,126,100 AA Damages	Administrative costs of Flood Insurance Program
(a) Recreation/Environmental	None	None	None
(b) Operation, Maintenance and Replacement	Emergency Preparation and relief costs	Emergency preparation and relief costs	Emergency preparation and relief costs
(2) Total Adverse Effects	Substantial	Substantial	Substantial
2. Environmental Quality			
a. EQ Enhanced			
(1) Man-made Resources	Only with the implementation of state and local projects to control flooding damages	Only with the implementation of state and local projects	N.A.
(2) Natural Resources			

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 3
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	NO ACTION PLAN LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(a) Air Quality	Slight Improvement	Little change	Clean Air Act applies
(b) Water Quality	Slight Improvement	Little change	Clean Water Act applies
(c) Land Quality	None	None	National policy applies
(d) Aquatic Ecosystems	None	None	Fish and Wildlife Act applies
(e) Terrestrial Ecosystems	None	None	Fish and Wildlife Act applies
(f) Threatened & Endangered Species	None	None	Endangered Species Act applies
(3) Historic and Prehistoric Sites	None	None	National Policy applies
(4) Noise	None	None	N.A.
b. EQ Degraded of Destroyed			
(1) Man-made Resources	Continued flooding of commercial and residential structures	Little change	N.A.

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 4
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	NO ACTION PLAN LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(2) Natural Resources			
(a) Air Quality	None	None	Clean Air Act applies
(b) Water Quality	None	None	Clean Water Act applies
(c) Land Quality	Continued loss of prime farm land due to flood-plain development	Continued loss to region	National Policy applies
(d) Aquatic Ecosystems	Total loss of wetlands Creek habitat largely destroyed by future urbanization	Moderate change	Fish and Wildlife Act applies
(e) Terrestrial ecosystems	Moderate loss of existing undeveloped habitat	Little change	Fish and Wildlife Act applies
(f) Threatened & Endangered	None	None	Endangered Species Act
(3) Historic and Prehistoric Sites	Continued significant degradation is expected	Little change	National Policy applies
(4) Noise	Slight increase to about 65 d BA's for newly urbanizing areas	Little change	N.A.

3. Social Well-being

a. Beneficial Impacts

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 5
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	NO ACTION PLAN		
	LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(1) Community Cohesion	None	None	N.A.
(2) Community Growth	None	None	N.A.
(3) Displacements	Likely displacements due to continued flooding not evaluated	None	N.A.
(4) Real Income Distribution	None	None	N.A.
(5) Educational, Cultural, and Recreational Opportunities	None Identified	None	N.A.
(6) Security of Life, Health, and Safety	Gradually reduces susceptibility of community to direct and indirect impacts of flooding	Insignificant	N.A.
(2) Community Growth	Hampered by flooding	Hampered by flooding	N.A.
(7) Aesthetics	Not quantified	Not quantified	N.A.
(8) Noise			
b. Adverse Impacts			
(1) Community Cohesion	Disrupted due to flooding	Disrupted due to flooding	N.A.
(3) Displacements	None	None	None
(4) Real Income Distribution	None	None	N.A

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 6
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	NO ACTION PLAN — LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(5) **Educational, Cultural, and Recreational Opportunities**			
(6) **Security of Life, Health, and Safety**	Continued flooding will cause further deterioration in existing development until relocated. Existing occupants will continue to be exposed to flood dangers until gradually relocated.	None	Positive, Not Quantified
(7) **Aesthetics**	Not quantified	Not quantified	N.A.
(8) **Noise**	65 dBA's average urban neighborhood	65 dBA's average urban neighborhood	N.A.
4. **Regional Development**			
a. **Beneficial Impacts**			
(1) **Income**	Reductions due to flooding not evaluated.	None	N.A.
(2) **Employment**	None	None	N.A.
(3) Property Values	No change	No change	N.A.
(4) Tax Revenues	No change	No change	N.A.
(5) Population Distribution	No change	No change	N.A.
(6) Regional Growth	No change	No change	N.A.
(7) Cash Contribution	N.A.	N.A.	N.A.

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 7
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	NO ACTION PLAN — LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(8) Public Facilities & Services	State/Local projects	State/local projects	N.A.
(9) Business & Industry	No basic change in trends	No basic change in trends	N.A.
(10) Displacement of Farms & Residences	None	None	N.A.
b. Adverse Impacts			
(1) Income	Losses due to flooding	Losses due to flooding	N.A.
(a) Project Construction	N.A.	N.A.	N.A.
(b) Operation, Maintenance, and Replacement	N.A.	N.A.	N.A.
(2) Employment	Potentially hampered by flooding	Potentially hampered by flooding	N.A.
(3) Property Values	Property value will remain depressed within the floodplain	Property value will remain depressed with the floodplain	N.A.
(4) Tax Revenues	No change	No change	N.A.
(5) Population Distribution	No change	No change	N.A.

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 8
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	NO ACTION PLAN — LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(6) Regional Growth	Hampered by flooding	Hampered by flooding	None
(7) Cash Contribution	N.A.	N.A.	N.A.
(8) Public Facilities & Services	State/local projects	State/local projects	N.A.
(9) Business & Industry	No basic change in trends	No basic change in trends	N.A.
(10) Displacement of Farms & Residences	None	None	N.A.

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 9
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	Recommended Plan		
	LOCATION OF IMPACTS		
ACCOUNTS	Study Area	Region	Rest of Nation
1. National Economic Development			
a. Beneficial Impacts			
(1) Value of Increased Outputs of Goods and Services			
(a) Flood Damage Reduction	$3,484,300 A.A.	$3,484,300 A.A.	$3,484,300 A.A.
(b) Land Enhancement	Not quantified (positive impact)	Not quantified	Not quantified
(c) Recreation/ Environmental	$226,100 A.A.	$226,100 A.A.	$226,100 A.A.
(2) Value of Increased Output Resulting from External Economies	Not evaluated (positive impact)	Not evaluated	Not evaluated
(3) Value of Output from Use of Unemployed or Underemployed Labor Resources (NED Employment)	No eligible areas	No eligible areas	No eligible areas
(4) Total Beneficial Effects	$3,710,400 A.A.	$3,710,400 A.A.	$3,710,400 A.A.

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 10
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	Recommended Plan		
	LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
b. Adverse Impacts			
(1) Project Costs	$2,209,000 A.A.	$2,209,000 A.A.	$2,209,000 A.A.
(a) Recreation/ Environmental Included in (1)	$202,100 A.A.	$202,100 A.A.	$202,100 A.A.
(b) Operation, Maintenance, & Replacement Included in (1)	$103,800 A.A.	$103,800 A.A.	$103,800 A.A.
(c) Loss of Productivity	None	None	None
(2) Losses Resulting from External Diseconomies	None	None	None
(3) Total Adverse Effects	$2,209.000 A.A.	$2,209,000 A.A.	$2,209,000 A.A.
2. Environmental Quality			
a. EQ Enhanced			
(1) Man-made Resources	Only with the implementation of state and local projects to control flooding damages.	Only with the implementation of state and local projects	N.A.
(2) Natural Resources			
(a) Air Quality	None	None	Clean Air Act supported

TABLE B 4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS PAGE 11
OCTOBER 1983 PRICE LEVEL AND 8 1/8 PERCENT INTEREST

	Recommended Plan – LOCATION OF IMPACTS: Study Area	Region	Rest of Nation
(b) Water Quality	None	Erosion control and oxygenation	Clean Air Act supported
(c) Land Quality	None	None	N.A.
(d) Aquatic Ecosystems	None	Some improvement	Fish and Wildlife Act
(e) Terrestrial Ecosystems	Provides a net gain of 80 undeveloped acres, and a net annualized monetary gain of $1,936 due primarily to increased non-consumptive wildlife activity.	Some regions were enhanced	Fish and Wildlife Act supported
(f) Threatened & Endangered Species	No significant impact.	Little change	Endangered Species Act supported
(3) Historic and Prehistoric Sites	Protection through purchase and maintenance of certain project lands in an undeveloped state, i.e., parks, dry detention area, etc. (1, 2, 3), (5), (8), (9)	Some improvement	National Policy applies
(4) Noise	None	None	N.A.
b. EQ Degraded or Destroyed			
(1) Man-made Resources	None	None	N.A.

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 12
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	Recommended Plan		
	LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(2) Natural Resources			
(a) Air Quality	Slight, localized due to construction	Slight localized due to construction	Clean Air Act supported
(b) Water Quality	Slight degradation during construction	Slight degradation due to construction	Clean Water Act supported
(c) Land Quality	None	Little change	National Policy supported
(d) Aquatic Ecosystems	Creek habitat degraded less than future without conditions.	Little change	Fish and Wildlife Act supported
(e) Terrestrial Ecosystems	Temporary construction-associated loss of woody vegetation	Construction related loss of woody vegetation	Fish and Wildlife Act supported
(f) Threatened & Endangered Species	None	Not evaluated	Endangered Species supported
(3) Historic and Prehistoric Sites	1 historic and 5 prehistoric sites	Some improvement	National ·olicy applies
(4) Noise	80 dBA's - during construction period	80 dBA's - during construction period	N.A.

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 13
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	Recommended Plan		
	LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
3. Social Well-being			
a. Beneficial Impacts			
(1) Community Cohesion	Improved (84% damage reduction)	Improved (84% damage reduction	National Policy supported
(2) Community Growth	Beneficial impact not evaluated	Beneficial impact not evaluated	Beneficial impact not evaluated
(3) Displacements	67 structures	67 structures	67 structures
(4) Real Income Distribution	Not evaluated	Not evaluated	Not evaluated
(5) Educational, Cultural, and and Recreational Opportunities	No impact	No impact	No impact
(6) Security of Life, Health, and Safety	Damage from SPF flood reduced by 61%	Damage from SPF flood reduced by 61%	National goals supported
(7) Aesthetics	Not quantified	Not quantified	Not quantified
(8) Noise	84 dBA's due to construction	84 dBA's due to construction	N.A.
b. Adverse Impacts			
(1) Community Cohesion	No adverse impacts	No adverse impacts	National goals supported

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 14
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	Recommended Plan		
	LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(2) Community Growth	No adverse impacts	No adverse impacts	National goals supported
(3) Displacements	67 structures	67 structures	National Policy supported
(4) Real Income Distribution	Not evaluated	Not evaluated	Not evaluated
(5) Educational, Cultural, and Recreational Opportunities	No adverse impacts	No adverse impacts	National goals supported
(6) Security of Life, Health, and Safety	Risk still exist	Risk still exist	National goal supported
(7) Esthetics	Not quantified	Not quantified	Not quantified
(8) Noise	84 dBA's due to construction	84 dBA's due to construction	N.A.
4. Regional Development			
a. Beneficial Impacts			
(1) Income	$21,925,700 new business activity	$21,925,700 new business activity	National goals supported
(2) Employment	384 man-years generated	384 man-years generated	National Policy supported

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 15
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	Recommended Plan		
	LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(3) Property Values	Probable increase in property value of structures in floodplain	Probable increase in property value of	National Policy supported
(4) Tax Revenues	$219,300 due to sales tax	$219,300 due to sales tax	National Policy supported
(5) Population Distribution	Not evaluated	Not evaluated	Not evaluated
(6) Regional Growth	$21,925,700 new business activity	$21,925,700 new business activity	Not evaluated
(7) Cash Contribution	Not evaluated	Not evaluated	Not evaluated
(8) Public Facilities & Services			
(9) Business & Industry	$21,925,700 new business activity	$21,925,700 new business activity	Not evaluated
(10) Displacement of Farms & Residences	65 residential structures	65 residential structures	65 residential structures
b. Adverse Impacts			
(1) Income	No significant impact	No significant impact	National goals supported
(2) Employment	No significant impact	No significant impact	National Policy supported

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 16
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	Recommended Plan		
	LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(3) Property Values	No adverse impacts	No adverse impacts	No adverse impact
(4) Tax Revenues	No significant impacts	No significant impacts	No significant impact
(5) Population Distribution	Not evaluated	Not evaluated	Not evaluated
(6) Regional Growth	No significant impacts	No significant impacts	National goals supported
(7) Cash Contribution	Not evaluated	Not evaluated	Not evaluated
(8) Public Facilities & Services			
(9) Business & Industry	2 commercial displaced	2 commercial displaced	National goals supported
(10) Displacement of Farms & & Residences	65 residential structures	65 residential structures	National goals supported

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 17
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	NED Plan		
	LOCATION OF IMPACTS		
ACCOUNTS	Study Area	Region	Rest of Nation
1. National Economic Development			
a. Beneficial Impacts			
(1) Value of Increased Outputs of Goods and Services			
(a) Flood Damage Reduction	$3,451,100 A.A.	$3,451,100 A.A.	$3,451,100 A.A.
(b) Land Enhancement	Not quantified	Not quantified	Not quantified
(c) Recreation/ Environmental	$183,800 A.A.	$183,800 A.A.	$183,800 A.A.
(2) Value of Increased Output Resulting from External Economies	Not quanitified	Not quantified	Not quantified
(3) Value of Output from Use of Unemployed or Underemployed Labor Resources (NED Employment)	No eligible areas	No eligible areas	No eligible areas
(4) Total Beneficial Effects	$3,634,900 A.A.	$3,634,900 A.A.	$3,634,900 A.A.

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 18
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	NED Plan		
	LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
b. Adverse Impacts			
(1) Project Costs - Flood Damage	$2,061,700 A.A.	$2,061,700 A.A.	$2,061,700 A.A.
(a) Recreation/ Environmental	$112,000 Included in (1)	$112,000 Included in (1)	$112,000 Included in (1)
(b) Operation, Maintenance	$57,100 A.A. Included in (1)(1a)	$57,100 A.A. Included in (1)(1a)	$57,100 A.A. Included in (1)(1a)
(c) Loss of Productivity	None	None	None
(2) Losses Resulting from External Diseconomies	Not evaluated	Not evaluated	Not evaluated
(3) Total Adverse Effects	$2,061,700 A.A.	$2,061,700 A.A.	$2,061,700 A.A.
2. Environmental Quality			
a. EQ Enhanced			
(1) Man-made Resources	Reduces flood damages to commercial and residential structures 84%	Little change	N.A.
(2) Natural Resources			
(a) Air Quality	None	None	Clean Air Act supported

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 19
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	NED Plan		
	LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(b) Water Quality	Slight improvement	Little change	Clean Water Act supported
(c) Land Quality	Slight reduction in soil erosion	None	National Policy supported
(d) Aquatic Ecosystems	None	None	Fish and Wildlife Act supported
(e) Terrestrial Ecosystems	Net annualized monetary gain and $235 in Recommended Plan	Little change	Fish and Wildlife Act supported
(f) Threatened & Endangered Species	None	None	Endangered Species Act supported
(3) Historic Structures	None	None	Historic Preservation Act supported
(4) Noise	None	None	N.A.
b. EQ Degraded or Destroyed			
(1) Man-made Resources	None	None	N.A.
(2) Natural Resources			
(a) Air Quality	Slight, localized degradation during construction	Slight, localized during construction	Clean Air Act supported

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 20
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	NED Plan LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(b) Water Quality	Slight, localized degradation during construction	Slight, localized during construction	Clean Air Act supported
(c) Land Quality	Minor loss of prime farm land	Little change	National Policy supported
(d) Aquatic Ecosystems	4.3 miles of creek habitat destroyed or degraded. Net annualized monetary losses are ($-491).	Little change	Fish and Wildlife Act supported
	Moderate long-term degradation along 4,330 feet of enlarged earthen channel		
(e) Terrestrial ecosystems	Construction associated loss of woody vegetation	Construction related loss of woody vegetation	Fish and Wildlife Act supported
(f) Threatened & Endangered Species	None	Not evaluated	Endangered Species supported
(3) Historic and Prehistoric Site	One historic site	None	National Policy Act
(4) Noise	74-84 dBA's (at 100 ft) - during construction period	Little change	N.A.

3. Social Well-being

a. Beneficial Impacts

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 21
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	NED Plan		
	LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(1) Community Cohesion	Improved (84% damage reduction)	Improved (84% damage reduction)	National Policy supported
(2) Community Growth			
(3) Displacements	2 commercial structure displaced 10 residential structures displaced	2 commercial structure displaced 10 residential structures displaced	National Policy supported
(4) Real Income Distribution	Not evaluated	Not evaluated	Not evaluated
(5) Educational, Cultural, and	No impact	No impact	No impact
(6) Security of Life, Health, and Safety	Damage from SPF flood reduced by 61%	Damage from SPF flood reduced by 61%	National goals supported
(7) Aesthetics	Not quantified	Not quantified	Not quantified
(8) Noise	84 dBA's due to construction	84 dBA's due to construction	N.A.
b. Adverse Impacts			
(1) Community Cohesion	No adverse impacts	No adverse impacts	National goals supported
(2) Community Growth	No adverse impacts	No adverse impacts	National Policy supported

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 22
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	NED Plan		
	LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(3) Displacements	2 commercial structure displaced 10 residential structures displaced	2 commercial structure displaced 10 residential structures displaced	National Policy supported
(4) Real Income Distribution	Not evaluated	Not evaluated	Not evaluated
(5) Educational, Cultural, and Recreational Opportunities	No adverse impacts	No adverse impacts	National goals supported
(6) Security of Life, Health, and Safety	Risks still exist	Risks still exist	National goals supported
(7) Aesthetics	Not quantified	Not quantified	Not quantified
(8) Noise	84 dBA's due to construction	84 dBA's due to construction	N.A.
4. Regional Development			
a. Beneficial Impacts			
(1) Income	$20,438,100 new business activity	$20,438,100 new business activity	National goals supported
(2) Employment	316 man-years generated	316 man-years generated	National policy supported
	plain		

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 23
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	NED Plan		
	LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(3) Property Values	Probable increase in property values of structures in floodplain	Probable increase in property values of structures in flood	National Policy supported
(4) Tax Revenues	$204,400 due to sales tax	$204,400 due to sales tax	National Policy supported
(5) Population Distribution	Not evaluated	Not evaluated	Not evaluated
(6) Regional Growth	$20,438,100 new business activity	$20,438,100 new business activity	National Policy supported
(7) Cash Contribution	Not evaluated	Not evaluated	Not evaluated
(8) Public Facilities & Services			
(9) Business & Industry	$20,438,100 new business activity	$20,438,100 New business activity	National Policy supported
(10) Displacement of Farms & Residences	10 residential structures	10 residential structures	National Policy supported
b. Adverse Impacts			
(1) Income	No adverse impact	No adverse impact	National goals supported
(2) Employment	No adverse impacts	No adverse impacts	National Policy supported

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS PAGE 24
OCTOBER 1983 PRICE LEVEL AND 8 1/8 PERCENT INTEREST

	NED Plan LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(3) Property Values	No adverse impacts	No adverse impacts	National Policy supported
(4) Tax Revenues	No adverse impacts	No adverse impacts	National Policy supported
(5) Population Distribution	Not evaluated	Not evaluated	Not evaluated
(6) Regional Growth	No adverse impacts	No adverse impacts	National goals supported
(7) Cash Contribution	Not evaluated	Not evaluated	Not evaluated
(8) Public Facilities & Services	No adverse impacts	No adverse impacts	National Policy supported
(9) Business & Industry	2 commercial structure displaced	2 commercial structure displaced	National goals supported
(10) Displacement of Farms & Residences	No impact	No impact	No impact

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 25
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	EQ Plan		
	LOCATION OF IMPACTS		
ACCOUNTS	Study Area	Region	Rest of Nation
1. National Economic Development			
a. Beneficial Impacts			
(1) Value of Increased Outputs of Goods and Services			
(a) Flood Damage Reduction	$3,755,500 A.A.	$3,775,500 A.A.	$3,775,500 A.A.
(b) Land Enhancement	Not quantified	Not quantified	Not quantified
(c) Recreation/ Environmental	$361,700 A.A.	$361,700 A.A.	$361,700 A.A.
(2) Value of Increased Output Resulting from External Economies	Not evaluated	Not evaluated	Not evaluated
(3) Value of Output from Use of Unemployed or Underemployed Labor Resources (NED Employment)	No eligible areas	No eligible areas	No eligible areas
(4) Total Beneficial Effects	$4,117,200 A.A.	$4,117,200 A.A.	$4,117,200 A.A.

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 26
OCTOBER 1981 PRICE LEVEL AND 7-5/8 PERCENT INTEREST

	EQ Plan		
	LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
b. Adverse Impacts			
(1) Project Costs	$3,260,800 A.A.	$3,280,800 A.A.	$3,260,800 A.A.
(a) Recreation/ Environmental Included in (1)	$600,000 A.A. (Included in 1 above)	$600,000 A.A.	$600,000 A.A.
(b) Operation, Mainte-nance, & Replacement Included in (1)	$147,700 A.A. (Included in 1, 1a above)	$147,700 A.A.	$147,700 A.A.
(2) Losses Resulting from External Diseconomies	None	None	None
(3) Total Adverse Effects	$3,260,800 A.A.	$3,260,800 A.A.	$3,260,800 A.A.
2. Environmental Quality			
a. EQ Enhanced			
(1) Man-made Resources	Reduces flood damages 93% to commercial and residential structures	Little change	N.A.
(2) Natural Resources			
(a) Air Quality	Some reduction in dust and fumes due to tree corridor and potentially from the urban wildlife program	Little change	Clean Air Act supported

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 27
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	EQ Plan		
	LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(b) Water Quality	increased erosion control along creek	erosion control along creek	Clean Air Act supported
(c) Land Quality	prime farmland loss reduction due to altered future land use	None	N.A.
(d) Aquatic Ecosystems	Fish pond improvements Slight habitat improvement due to trash removal	Some improvement	Fish and Wildlife Act supported
(e) Terrestrial Ecosystems	Provides a net annualized monetary gain of $2,560	enhanced	supported
(f) Threatened & Endangered Species	Enhancement of non-critical habitat	Little change	Endangered Species Act supported
(3) Historic and Prehistoric Sites	Protection through purchase and maintenance of certain project lands in an undeveloped state (i.e., dry detention area)	Some improvement	National Policy applies

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 28
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	EQ Plan		
	LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(4) Noise	None	None	N.A.
b. EQ Degraded or Destroyed			
(1) Man-made Resources	None	None	N.A.
(2) Natural Resources			
(a) Air Quality	Slight, localized due to construction	Slight localized due to construction	Clean Air Act supported
(b) Water Quality	Slight degradation during construction	Slight degradation due to construction	Clean Water Act supported
(c) Land Quality	None	None	National Policy supported
(d) Aquatic Ecosystems	4.3 miles of creek habitat destroyed or degraded offset by fish pond, aquatic habitat and EQ (tree) corridor installation net impact is ($-400).	Little change	Fish and Wildlife Act supported
(e) Terrestrial Ecosystems	Short-term Construction associated loss of woody vegetation	Construction related loss of woody vegetation	Fish and Wildlife Act supported
(f) Threatened & Endangered Species	None	Not evaluated	Endangered Species supported

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 29
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	EQ Plan		
	LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(3) Historic and Prehistoric Sites	1 historic and 5 prehistoric sites	Some improvement	National Policy applies
(4) Noise	80 dBA's - during construction period	80 dBA's - during construction period	N.A.
3. Social Well-being			
a. Beneficial Impacts			
(1) Community Cohesion	Improved (93% damage reduction)	Improved (93% damage reduction	National Policy supported
(2) Community Growth			
(3) Displacements	67 structures	67 structures	67 structures
(4) Real Income Distribution	Not evaluated	Not evaluated	Not evaluated
(5) Educational, Cultural, and and Recreational Opportunities	No impact	No impact	No impact
(6) Security of Life, Health, and Safety	Damage from SPF flood reduced	Damage from SPF flood reduced	National goals supported
(7) Aesthetics	Not quantified	Not quantified	Not quantified
(8) Noise	84 dBA's due to construction	84 dBA's due to construction	N.A.

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 30
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	EQ Plan		
	LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
b. Adverse Impacts			
(1) **Community Cohesion**			
(2) **Community Growth**			
(3) **Displacements**	67 structures	67 structures	National Policy supported
(4) **Real Income Distribution**	Not evaluated	Not evaluated	Not evaluated
(5) **Educational, Cultural, and Recreational Opportunities**	No adverse impacts	No adverse impacts	National goals supported
(6) **Security of Life, Health, and Safety**	Risk still exist	Risk still exist	National goal supported
(7) **Esthetics**	Not quantified	Not quantified	Not quantified
(8) **Noise**	84 dBA's due to construction	84 dBA's due to construction	N.A.
4. Regional Development			
a. Beneficial Impacts			
(1) **Income**	$32,468,200 new business activity	$32,468,200 new business activity	National goals supported
(2) **Employment**	502 man-years generated	502 man-years generated	National Policy supported

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 31
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	EQ Plan		
	LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(3) Property Values	Probable increase in property value of structures in floodplain	Probable increase in property value of	National Policy supported
(4) Tax Revenues			
(5) Population Distribution	Not evaluated	Not evaluated	Not evaluated
(6) Regional Growth	$32,468,200 new business activity	$32,468,200 new business activity	Not evaluated
(7) Cash Contribution	Not evaluated	Not evaluated	Not evaluated
(8) Public Facilities & Services			
(9) Business & Industry	$32,468,200 new business activity	$32,468,200 new business activity	Not evaluated
(10) Displacement of Farms & Residences	66 residential structures	66 residential structures	66 residential structures
b. Adverse Impacts			
(1) Income	No significant impact	No significant impact	National goals supported
(2) Employment	No significant impact	No significant impact	National Policy supported
(3) Property Values	No adverse impacts	No adverse impacts	No adverse impact

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 32
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	EQ PLAN		
	LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(4) Tax Revenues	$324,700 due to sales tax	$324,700 due to sales tax	National policy supported
(5) Population Distribution	Not evaluated	Not evaluated	Not evaluated
(6) Regional Growth	No significant impacts	No significant impacts	National goals supported
(7) Cash Contribution	Not evaluated	Not evaluated	Not evaluated
(8) Public Facilities & Services			
(9) Business & Industry	2 commercial displaced	2 commercial displaced	National goals supported
(10) Displacement of Farms & & Residences	66 structures	66 structures	National goals supported

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 9
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	Plan "A"		
	LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
1. National Economic Development			
a. Beneficial Impacts			
(1) Value of Increased Outputs of Goods and Services			
(a) Flood Damage Reduction	$3,755,500 A.A.	$3,755,500 A.A.	$3,755,500 A.A.
(b) Land Enchantment	Not quantified	Not quantified	Not quantified
(c) Recreation/ Environmental	$233,500 A.A.	$233,500 A.A.	$233,500 A.A.
(2) Value of Increased Output Resulting from External Economics	Not evaluated	Not evaluated -	Not evaluated
(3) Value of Output from Use of Unemployed or Underemployed Labor Resources (NED Employment)	No eligible areas	No eligible areas	No eligible areas
(4) Total Beneficial Effects	$3,989,000 A.A.	$3,989,000 A.A.	$3,989,000 A.A.

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 10
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	Plan "A" — LOCATION OF IMPACTS: Study Area	Region	Rest of Nation
b. Adverse Impacts			
(1) Project Costs	$2,916,400 A.A.	$2,916,400 A.A.	$2,916,400 A.A.
(a) Recreation/ Environmental Included in (1)	$92,300 A.A.	$92,300 A.A.	$92,300 A.A.
(b) Operation, Maintenance & Replacement Included in (1)	$144,700 A.A.	$144,700 A.A.	$144,700 A.A.
(c) Loss of Productivity	None	None	None
(2) Losses Resulting from External Diseconomies	None	None	None
(3) Total Adverse Effects	$2,916,400 A.A.	$2,916,400 A.A.	$2,916,400 A.A.
2. Environmental Quality			
a. EQ Enhanced			
(1) Man-made Resources	Only with the implementation of state and local projects to control flooding damages.	Only with the implementation of state and local projects	N.A.
(2) Natural Resources			
(a) Air Quality	None	None	Clean Air Act supported

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 11
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

Plan "A"

	LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(b) Water Quality	One habitat control structure and erosion control.	one habitat control structure, erosion control and oxygenation	Clean Air Act supported
(c) Land Quality	None.	None.	N.A.
(d) Aquatic Ecosystems	One habitat structure.	Some improvement	Fish and Wildlife Act
	30 acres of wetland potentially preserved.		
(e) Terrestrial Ecosystems	Net annualized monetary gain of $1,633 due primarily to increased non-consumptive wildlife activity.	Some regions were enhanced	Fish and Wildlife Act supported
(f) Threatened & Endangered Species	Enhancement of non-critical habitat	Little change	Endangered Species Act supported
(3) Historic and Prehistoric Sites	Protection through purchase and maintenance of certain project lands in an undeveloped state, i.e., parks, dry detention area, etc. (1, 2, 3), (5), (8), (9)	Some improvement	National Policy applies
(4) Noise	None	None	N.A.
b. EQ Degraded or Destroyed			
(1) Man-made Resources	None	None	N.A.

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 12
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	Plan "A"		
	LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(2) Natural Resources			
(a) Air Quality	Slight, localized due to construction	Slight localized due to construction	Clean Air Act supported
(b) Water Quality	Slight degradation during construction	Slight degradation due to construction	Clean Water Act supported
(c) Land Quality	None	Little change	National Policy supported
(d) Aquatic Ecosystems	4.3 miles of creek habitat destroyed or degraded offset by aquatic habitat structures with net (-491) effect	Little change	Fish and Wildlife Act supported
(e) Terrestrial Ecosystems	Temporary construction-associated loss of woody vegetation	Construction related loss of woody vegetation	Fish and Wildlife Act supported
(f) Threatened & Endangered Species	None	Not evaluated	Endangered Species supported
(3) Historic and Prehistoric Sites	1 historic and 5 prehistoric sites	Some improvement	National Policy applies
(4) Noise	80 dBA's - during construction period	80 dBA's - during construction period	N.A.

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 13
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	Plan "A"		
	LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
3. Social Well-being			
a. Beneficial Impacts			
(1) **Community Cohesion**	Improved (92% damage reduction)	Improved (92% damage reduction	National Policy supported
(2) **Community Growth**			
(3) **Displacements**	67 structures	67 structures	67 structures
(4) **Real Income Distribution**	Not evaluated	Not evaluated	Not evaluated
(5) **Educational, Cultural, and and Recreational Opportunities**	No impact	No impact	No impact
(6) **Security of Life, Health, and Safety**	Damage from SPF flood reduced by 92%	Damage from SPF flood reduced by 92%	National goals supported
(7) **Aesthetics**	Not quantified	Not quantified	Not quantified
(8) **Noise**	84 dBA's due to construction	84 dBA's due to construction	N.A.
b. Adverse Impacts			
(1) **Community Cohesion**	No adverse impacts	No adverse impacts	National goals supported

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 14
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	Plan "A" — LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(2) **Community Growth**	No adverse impacts	No adverse impacts	National goals supported
(3) **Displacements**	67 structures	67 structures	National Policy supported
(4) **Real Income** Distribution	Not evaluated	Not evaluated	Not evaluated
(5) **Educational, Cultural, and Recreational** Opportunities	No adverse impacts	No adverse impacts	National goals supported
(6) **Security of** Life, Health, **and Safety**	Risk still exist	Risk still exist	National goal supported
(7) **Esthetics**	Not quantified	Not quantified	Not quantified
(8) **Noise**	84 dBA's due to construction	84 dBA's due to construction	N.A.
4. **Regional Development**			
a. **Beneficial Impacts**			
(1) **Income**	$28,910,900 new business activity	$28,910,900 new business activity	National goals supported
(2) **Employment**	447 man-years generated	447 man-years generated	National Policy supported

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 15
OCTOBER 1983 PRICE LEVEL AND 8-1/8 PERCENT INTEREST

	Plan "A"		
	LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(3) Property Values	Probable increase in property value of structures in floodplain	Probable increase in property value of	National Policy supported
(4) Tax Revenues	$289,100 due to sales tax	$289,100 due to sales tax	National Policy supported
(5) Population Distribution	Not evaluated	Not evaluated	Not evaluated
(6) Regional Growth	$28,910,000 new business activity	$28,910,000 new business activity	Not evaluated
(7) Cash Contribution	Not evaluated	Not evaluated	Not evaluated
(8) Public Facilities & Services			
(9) Business & Industry	$28,910,000 new business activity	$28,910,000 new business activity	Not evaluated
(10) Displacement of Farms & Residences	66 residential structures	66 residential structures	66 residential structures
b. Adverse Impacts			
(1) Income	No significant impact	No significant impact	National goals supported
(2) Employment	No significant impact	No significant impact	National Policy supported

TABLE B-4
CAPE LA CROIX CREEK AND WALKER BRANCH
STAGE 3 SYSTEM OF ACCOUNTS - PAGE 16
OCTOBER 1983 PRICE LEVEL AND 8 1/8 PERCENT INTEREST

	Plan "A"		
	LOCATION OF IMPACTS		
	Study Area	Region	Rest of Nation
(3) Property Values	No adverse impacts	No adverse impacts	No adverse impact
(4) Tax Revenues	No significant impacts	No significant impacts	No significant impact
(5) Population Distribution	Not evaluated	Not evaluated	Not evaluated
(6) Regional Growth	No significant impacts	No significant impacts	National goals supported
(7) Cash Contribution	Not evaluated	Not evaluated	Not evaluated
(8) Public Facilities & Services			
(9) Business & Industry	2 commercial displaced	2 commercial displaced	National goals supported
(10) Displacement of Farms & & Residences	66 residential structures	66 residential structures	National goals supported

RECOMMENDED PLAN PERFORMANCE

139. The basic performance anticipated by installation of the Recommended Plan is discussed under the topics of flood control, outdoor recreation, environmental evaluation, and public acceptance.

FLOOD CONTROL

140. The Recommended Plan of improvements would provide effective and efficient high levels of urban flood protection utilizing both structural and nonstructural measures, provides recreation, and is economically feasible. The plan reduces tangible damages by 84 percent

141. Degree of protection has traditionally been used as an indicator of project performance. Structural measures, such as levees, provide a fixed uniform protection to all structures. In developing a plan using a mixture of measures, some measures will provide one level of protection while others will provide a different level to another. Therefore, it is misleading to leave the impression that the same protection is provided to all structures. For this reason the indicator degree of protection in its traditional sense as one value for all structures is not useful because it may mislead non-technical participants. TABLE B-5 provides a more useful tabulation of flood damage prevention effectiveness which better describes the level of protection afforded by the Recommended Plan. This table shows event damages with and without the Recommended Plan by flood probability. Notice that 93.9 percent of the damages from the 50 percent chance flood (2-year) are eliminated with the Recommended Plan; and the Recommended Plan eliminates 60.8 percent of all damages of a flood event with a 0.2 percent probability (500-year).

TABLE B-5
CAPE LA CROIX CREEK AND WALKER BRANCH
RECOMMENDED PLAN
FLOOD DAMAGE PREVENTION EFFECTIVENESS
BASED ON OCTOBER 1983 PRICE LEVEL

Probability of Occurrence	Flood Event In Years	Event Damage No Plan	Event Damage Recommended Plan	Percent Damage Reduction
0.2%	500	$27,604,500	$10,804,200	60.9
1.0	100	22,093,500	6,675,100	69.8
2.0	50	18,063,000	3,963,000	78.1
10.0	10	9,950,000	1,656,200	83.4
20.0	5	5,399,000	1,089,300	79.8
50.0	2	2,361,400	143,000	94.0

142. The percent damage reduction values shown on TABLE B-5 indicate the significant effectiveness of the basic flood control management measures. The flood damage areas happen to be located along Cape La Croix Creek and Walker Branch so as to allow high levels of flood damage reduction by improvements incurring relatively modest costs.

143. The Recommended Plan would provide 100-year protection for 330 structures with 92 additional structures protected from first floor flooding but subject to basement damages due to their location on the floodway.

144. In terms of flood flows and flood elevations, the Recommended Plan would provide a significant improvement in flooding conditions were floods similar to the 1973 or 1977 floods to recur.

145. Analysis of the Recommended Plan runoff hydrographs for the floods with 50, 10, 1 and 0.2 percent chance of occurence was accomplished throughout the basin. The peak flows on Cape La Croix Creek at Hopper Road are reduced considerably due to the storage effect of the dry detention reservoir. Above Walker Branch, the reduction in flows is less due to the effect of channel improvements, but significantly reduced flood elevations result. The Recommended Plan is effective in reducing the size of the flood area by basically reducing flood elevation.

OUTDOOR RECREATION

146. The Recommended Plan of improvements makes a significant contribution towards satisfying the future outdoor recreation demands in a cost effective manner. The measure of successful outdoor recreation improvements is the anticipated visitor day attendance satisfied. When converted to tangible economic benefits, the Recommended Plan is credited with $226,100 average annual benefits for recreationally oriented pursuits. These benefits occur as a direct result of the miles of hiking and biking trails on Cape La Croix and Walker Branch. The various recreational sites provide picnic tables, acres of open play area and miles of nature trails. The Recommended Plan also provides one group camp area, two exercise trails and a disc course.

147. The economic performance of the Recommended Plan is presented in TABLE B-6. Recreation is well justified as an independent function. (See APPENDIX F)

TABLE B-6
SUMMARY OF BENEFITS AND COSTS FOR THE RECOMMENDED PLAN
October 1983 Price Level
8-1/8% Interest Rate
Based on $25,900,000 project first cost

Benefit Category	Average Annual Benefits	Average Annual Costs	BCR	Net Benefits
Flood Control	$3,484,300	$2,135,400	1.63	$1,348,900
Recreation	226,100	73,600	3.07	152,500
PROJECT TOTAL	$3,710,400	$2,209,000	1.68	$1,501,400

ENVIRONMENTAL EVALUATION

148. The Recommended Plan of improvements captures a limited portion of the environmental opportunities available. Because the environmental concerns are largely intangible ones this study was careful not to overlook or ignore these issues.

149. Opportunities to preserve dwindling terrestrial and aquatic community habitates exist along Cape La Croix Creek and Walker Branch. The opportunities are all the more significant due to their urban setting. The spread of urbanization continues to displace aquatic and terrestrial creatures and destroy their habitat. The Recommended Plan of improvements provides some minimal measures for reducing some of the anticipated future aquatic and terrestrial habitat losses, though its main emphasis is in providing high levels of flood protection.

150. The environmental opportunities are partially captured by the Recommended Plan in provisions for hike and bike trails, and recreation features at the dry detention reservoir site.

151. Detailed data identifying the Recommended Plan environmental performance and impacts may be found in APPENDIX F.

PUBLIC ACCEPTANCE

152. The Recommended Plan of improvements enjoys a rather high level of public acceptance which is expressed through the sponsor, the Cape La Croix Creek and Walker Branch Levee and Drainage District. This is most likely due to its commendable performance in the flood control, and recreational areas of concern. The plan's substantial benefit to cost ratio allows Federal cost sharing which may help to explain the enthusiastic local acceptance.

153. Another key factor impacting and explaining the Recommended Plan public acceptance is the fact that flooding has regularly occurred in the study area during recent times. Dollar damages, intangible losses, suffering and physical labor involved in coping with a real life flood event are still relatively fresh in the minds of local citizens and government officials.

154. The Federal and non-Federal construction cost sharing by project purpose based on October 1983 price levels is shown in TABLE B-7.

155. More specific cost analysis and detailed identification of the cost sharing requirements for construction costs, operation/maintenance and major replacement annual costs may be found in APPENDIX D.

CONCLUSION

156. It is concluded that the Recommended Plan of improvements is a worthwhile local, state, and Federal partnership investment that will return significantly more tangible dollar benefits than it will cost. Flood damages are strongly addressed, outdoor recreational deficiencies are satisfied, and environmental opportunities are captured.

TABLE B-7
CAPE LA CROIX CREEK AND WALKER BRANCH
FEDERAL AND NON-FEDERAL CONSTRUCTION COSTS
BASED ON OCTOBER 1983 PRICE LEVELS
RECOMMENDED PLAN

ITEM	LANDS	RELOCATIONS	IMPROVEMENTS	TOTALS
1. FEDERAL COSTS				
a. Flood control	$ 980,000	$ 370,000	$19,119,000	$20,469,000
b. Recreation	11,000	0	220,000	231,000
c. Subtotal	$ 991,000	$ 370,000	$19,339,000	$20,700,000
2. NON-FEDERAL COSTS				
a. Flood control	$2,691,000	$2,006,000	$ 0	$ 4,697,000
b. Recreation	189,000	0	314,000	503,000
c. Subtotal	$2,880,000	$2,006,000	$ 314,000	$ 5,200,000
3. Summary of First Costs, Federal Plus Non-Federal, by Project Purpose				
a. Flood Control	$3,671,000	$2,376,000	$19,119,000	$25,166,000
b. Recreation	200,000	0	534,000	734,000
d. Total Costs	$3,871,000	$2,376,000	$19,653,000	$25,900,000

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PUBLIC VIEWS AND RESPONSES

SEE VOLUME FOUR

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APPENDIX D

HYDRAULICS AND HYDROLOGY

CAPE GIRARDEAU-JACKSON

APPENDIX D

HYDRAULICS AND HYDROLOGY

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APPENDIX D

HYDRAULICS AND HYDROLOGY

1. The purpose of this appendix is to present a summary of the detailed hydrologic and hydraulic analyses for the Cape Girardeau-Jackson study. This appendix covers only the Cape La Croix Creek and Walker Branch basins. A summary of the more pertinent facts leading to selection of the recommended plan of improvements is presented herein.

BACKGROUND INFORMATION

2. Cape La Croix Creek has its headwaters in the steep hills about 4 miles north of the city of Cape Girardeau, Missouri. From there it flows southward, through the city to it's confluence with the Mississippi River at about river mile 50.2. The Cape La Croix basin, shown in PLATE D-1 covers an area of about 21.4 square miles and has an average slope of about 29.5 feet per mile. The upper part of the basin, above the north crossing of U.S. Highway 61 over the creek, is very steep and only sparsely developed. Most of the area is wooded or open pasture land with scattered residential and agricultural development. Between the north Highway 61 and Bloomfield Road crossings over Cape La Croix Creek there is extensive urban development including residential, commercial and industrial developments as well as parks and open bottomland areas. Walker Branch, the major tributary to Cape La Croix, enters the creek in this reach. The Walker Branch basin is highly developed with residential areas upstream and commercial areas downstream of Broadway. The joint flood plain of Cape La Croix Creek and Walker Branch has been severely encroached upon with development extending out to the high banks in many cases. South of Bloomfield Road, development is not as heavy with more open bottomland available.

AVAILABLE BASIC DATA

3. At the time of this study, there were no streamflow or stage gages for Cape La Croix Creek or its tributaries. However, two recent severe storms produced many well documented high water marks in the basin. There are daily point rainfall totals available for the Cape Girardeau Airport and Jackson, Missouri gages. The nearest hourly precipitation recording station is at Advance, Missouri. Several local residents maintain rainfall gages in the basin and were helpful in the study.

HISTORICAL EVENTS

4. Flooding from Cape La Croix Creek and Walker Branch generally occurs in the spring and summer months as a result of intense thunderstorms over the watershed but could occur during any month of the year. These floods

have a rapid rate of rise and are of short duration but have caused tremendous damages in recent years. The floods of August 1952, June and July 1958 and May 1957 were described in the Flood Plain Information Study for Cape Girardeau, published in 1969. The May 1973 and March 1977 floods were described in the Flood Insurance Study for Cape Girardeau, published in 1978. In the 1973 storm, 9.71 inches of rainfall were recorded at the Cape Girardeau Airport, south of the basin, and 2.94 inches at Jackson, Missouri, just northwest of the basin. In the 1977 storm, 7.52 inches of rainfall fell at the Cape Girardeau Airport and 6.48 inches at Jackson. Several local citizens who maintain rain gages reported about 9 inches of rainfall in the central part of the basin, which was verified by city officials. Rainfall for the May 1973 and March 1977 storms was taken from National Oceanic and Atmospheric Administration (NOAA) Climatological Data for Missouri and Illinois for gages in the area. PLATES D-2 and D-3 show the isohyet patterns of the 26-27 May 1973 and 27-28 March 1977 storms, respectively. Although no major floods have occurred since 1977, the streams have been out of banks numerous times, closing local roads and causing considerable damage. The most recent example occurred on 27 August 1982 when 5.5 inches of rain recorded at Jackson caused Cape La Croix Creek and Walker Branch to overtop their banks flooding residences and businesses.

HYDROLOGIC AND HYDRAULIC MODELING

5. The computer models used to perform the hydrologic and hydraulic analyses are discussed in this section. The methods used to verify these models are also presented.

HYDROLOGIC MODELING

6. The computer program "HEC-1, Flood Hydrograph Package" was used in performing the hydrologic analyses. The Cape La Croix Creek basin was divided into 25 subareas as shown in PLATE D-1. Six hour SCS synthetic unit hydrographs with five minute intervals were developed for the 25 subareas using HEC-1. Soil maps provided by the Soil Conservation Service office in Jackson, Missouri, indicate that the dominant soil types in the basin are Menfro silt loam in the uplands and Haymond silt loam in the flood plains, both of which are in the hydrologic soil group B. Present land use maps prepared by Southeastern Missouri Planning Commission, and the SCS Handbook of Hydrology were used to compute a weighted runoff curve number for each subarea. TABLE D-1 shows the area and SCS curve number for present land use and the computed, weighted curve number for each of the subareas.

The time of concentration was computed for each subarea by the use of the Kirpich formula, $TC = 0.0078\ (L/S)^{0.770}$. In the subareas where urban development was heavy, adjustments were made to decrease the TC. The drainage area length, vertical drop, slope, adjusted TC and lag are shown for each subarea in TABLE D-2 for present conditions.

TABLE D-1

LAND USE
CAPE LA CROIX CREEK BASIN

	PRESENT LAND USE				FUTURE LAND USE			
Subarea No.	Land Use	SCS Curve No.	Area (Sq. Mi.)	Weighted Curve No.	Land Use	SCS Curve No.	Area (Sq. Mi.)^2	Weighted Curve No.
10	Woods	62	1.7		Residential	72	0.4	
	Pasture (Poor)	79	1.0		Woods	72	1.7	
	Agriculture	78	.7		Pasture (Poor)	79	0.7	
					Agriculture	78	0.6	
			3.4	70			3.4	70
20	Woods	62	.55		Residential	75	1.05	
	Pasture (Fair-Poor)	75	.80		Woods	62	0.2	
	Agriculture	78	.20		Pasture	75	0.2	
					Open Developed	61	0.1	
			1.55	70			1.55	73
30	Woods	62	.32		Residential	75	0.23	
	Pasture	75	.35		Woods	60	0.30	
	Agriculture	78	.35		Pasture	69	0.24	
					Agriculture	78	0.25	
			1.02	72			1.02	72

TABLE D 1 (Continued)

LAND USE
CAPE LA CROIX CREEK BASIN

	PRESENT LAND USE				FUTURE LAND USE			
Subarea No.	Land Use	SCS Curve No.	Area (Sq. Mi.)	Weighted Curve No.	Land Use	SCS Curve No.	Area (Sq. Mi.)^2	Weighted Curve No.
40	Woods	62	.22		Residential	75	0.06	
	Pasture	75	.50		Woods	62	0.22	
	Agriculture	78	.15		Pasture	75	.48	
					Agriculture	78	.10	
			0.87	72			0.87	72
50	Woods	62	1.00		Residential	75	.72	
	Pasture	75	1.80		Open Developed	61	.03	
	Agriculture	78	.28		Commercial	96	.01	
					Agriculture	78	.26	
					Woods	62	.97	
					Pasture	75	1.09	
			3.08	72			3.08	72
60	Woods	60	.15		Commercial	96	.02	
	Pasture (Fair)	69	.15		Open Developed	61	.02	
	Agriculture	78	.32		Pasture	69	.01	
					Residential	75	.57	
			0.62	71			.62	75

TABLE D 1 (Continued)

LAND USE
CAPE LA CROIX CREEK BASIN

	PRESENT LAND USE				FUTURE LAND USE			
Subarea No.	Land Use	SCS Curve No.	Area (Sq. Mi.)	Weighted Curve No.	Land Use	SCS Curve No.	Area (Sq. Mi.)^2	Weighted Curve No.
70	Woods	60	.25		Commercial	96	.05	
	Pasture	69	.30		Residential	75	.66	
	Agriculture	78	.16					
			.71	68			.71	76
80	Pasture	69	.20		Commercial	96	.09	
	Residential	75	.24		Open Developed	61	.01	
					Residential	75	.34	
			.44	72			.44	79
90	Woods	60	.25		Commerical	96	.02	
	Pasture	69	.12		Open Developed	61	.01	
	Agriculture	78	.26		Residential	75	.70	
	Residential	75	.10					
			.73	70			.73	75
100	Woods	60	.10		Open Developed	61	.07	
	Pasture	69	.68		Commercial	96	.20	
	Agriculture	78	.12		Residential	75	1.10	
	Residential	75	.47					
			1.37	71			1.37	77

TABLE D-1 (Continued)

LAND USE
CAPE LA CROIX CREEK BASIN

	PRESENT LAND USE				FUTURE LAND USE			
Subarea No.	Land Use	SCS Curve No.	Area (Sq. Mi.)	Weighted Curve No.	Land Use	SCS Curve No.	Area (Sq. Mi.)^2	Weighted Curve No.
110	Pasture	69	.05		Residential	75	.24	
	Residential	75	.20		Commercial	96	.01	
			.25	74			.25	76
120	Commercial	96	.05		Commercial	96	.09	
	Residential	75	.10		Residential	75	.15	
			.24	79			.24	83
130	Industrial	88	.03		Commercial	96	.02	
	Commercial	96	.02		Industrial	88	.05	
	Open Developed	61	.12		Residential	75	.03	
	Residential	75	.03		Open Developed	61	.10	
			.20	71			.20	73
140	Commercial	96	.15		Residential	75	.02	
	Pasture	69	.09		Open Developed	61	.02	
	Residential	75	.02		Commercial	96	.16	
					Industrial	88	.06	
			.26	85			.26	90

TABLE D-1 (Continued)

LAND USE
CAPE LA CROIX CREEK BASIN

	PRESENT LAND USE				FUTURE LAND USE			
Subarea No.	Land Use	SCS Curve No.	Area (Sq. Mi.)	Weighted Curve No.	Land Use	SCS Curve No.	Area (Sq. Mi.)^2	Weighted Curve No.
150	Pasture	69	.22		Commercial	96	.02	
	Woods	60	.10		Open Developed	61	.08	
	Residential	75	.24		Residential	75	.46	
			.56	70			.56	74
160	Agriculture	78	.02		Open Developed	61	.09	
	Pasture	69	.33		Water Surface	100	.01	
	Woods	60	.22		Residential	75	1.13	
	Residential	75	.66					
			1.23	71			1.23	74
170	Pasture	69	.12		Industrial	88	.03	
	Open Developed	61	.16		Open Developed	61	.18	
	Commercial	96	.10		Commercial	96	.13	
	Residential	75	.62		Residential	75	.66	
			1.00	74			1.00	76
180	Commercial	96	.19		Industrial	88	.13	
	Industrial	88	.05		Commercial	96	.09	
	Open Developed	61	.03		Developed Open	61	.05	
	Residential	75	.19		Residential	75	.19	
			0.46	84			.46	84

TABLE D-1 (Continued)

LAND USE
CAPE LA CROIX CREEK BASIN

Subarea No.	Present Land Use: Land Use	Present: SCS Curve No.	Present: Area (Sq. Mi.)	Present: Weighted Curve No.	Future Land Use: Land Use	Future: SCS Curve No.	Future: Area (Sq. Mi.)^2	Future: Weighted Curve No.
190	Commercial	96	.05		Developed Open	61	.04	
	Industrial	88	.04		Commercial	96	.09	
	Residential	75	.18		Industrial	88	.14	
	Woods	60	.06		Residential	75	.26	
	Pasture	69	.20					
			.53	74			.53	81
200	Woods	60	.10		Industrial	88	.15	
	Commercial	96	.12		Open Developed	61	.07	
	Residential	75	.14		Commercial	96	.04	
	Pasture	69	.19		Residential	75	.29	
			.55	75			.55	78
210	Woods	60	.05		Industrial	88	.08	
	Residential	75	.13		Open Developed	61	.17	
	Pasture	69	.25		Residential (Heavy)	85	.18	
			.43	70			.43	76

TABLE D 1 (Continued)

LAND USE
CAPE LA CROIX CREEK BASIN

Subarea No.	Land Use	SCS Curve No.	Area (Sq. Mi.)	Weighted Curve No.	Land Use	SCS Curve No.	Area (Sq. Mi.)[2]	Weighted Curve No.
	PRESENT LAND USE				FUTURE LAND USE			
220	Pasture	69	.22		Industrial	88	.04	
	Commercial	96	.06		Open Developed	61	.10	
	Residential (Heavy)	85	.63		Commercial	96	.09	
					Residential (Heavy)	85	.68	
			.91	82			.91	84
230	Pasture	69	.10		Industrial	88	.04	
	Woods	60	.03		Open Developed	61	.03	
					Commercial	96	.06	
			.13	67			.13	85
240	Woods	60	.03		Industrial	88	.40	
	Industrial	88	.04		Residential	75	.08	
	Pasture	69	.43		Commercial	96	.02	
			.50	70			.50	86
250	Woods	60	.06		Industrial	88	.40	
	Industrial	88	.03					
	Residential	75	.03					
	Pasture	69	.28					
			.40	70			.40	88

TABLE D-2

BASIN CHARACTERISTICS
CAPE LA CROIX CREEK
PRESENT CONDITIONS

Sub-Basin No.	DA Sq. Mi.	Length ft.	H ft.	Slope ft./ft.	Adj. TC Min.
10	3.37	19,500	333	.0171	75
20	1.55	16,000	260	.0163	60
30	1.02	12,100	284	.0235	45
40	0.87	10,600	232	.0219	40
50	3.08	16,200	227	.0140	70
60	0.62	8,100	194	.0240	35
70	0.71	8,800	214	.0243	35
80	0.44	9,500	202	.0213	40
90	0.73	10,150	212	.0209	40
100	1.37	11,500	164	.0143	25
110	0.25	4,800	113	.0235	15
120	0.24	6,100	123	.0202	20
130	0.20	5,170	81	.0157	15
140	0.26	4,000	111	.0278	10
150	0.56	11,100	271	.0244	30
160	1.23	12,900	281	.0218	30
170	1.00	7,900	138	.0175	20
180	0.46	6,100	106	.0174	15
190	0.53	7,650	190	.0248	20
200	0.55	7,850	180	.0229	25
210	0.43	8,240	87	.0106	25
220	0.91	9,400	182	.0194	15
230	0.13	3,000	75	.0250	20
240	0.50	9,500	116	.0122	50
250	0.40	7,300	98	.0134	40
Total	= 21.41				

Storage-outflow data for the Modified Puls routing method was obtained directly from the HEC-2 model by computing several water surface profiles assuming flow values covering the range of possible flows. A schematic of the modeling technique is shown in PLATE D-4. It was assumed that U.S. Highway 61 divided the joint flood plains of Cape La Croix Creek and Walker Branch so that Walker Branch flows entered Cape La Croix Creek at Mile 3.14. However, in the 1977 flood, it was observed that a portion of flow in the left overbank of Cape La Croix Creek was diverted to the Walker Branch channel at Independence Street. A rating curve was constructed which indicated that 40 percent of the Cape La Croix Creek left overbank flow should be diverted to Walker Branch in the model. Therefore, flows were decreased on Cape La Croix Creek between miles 3.14 and 3.69 and increased on Walker Branch between its mouth and mile .40 by 40 percent of the left overbank flow of Cape La Croix Creek at mile 3.69.

HYDRAULIC MODELING

7. The computer program "HEC-2, Water Surface Profiles" was used to compute the water surface profiles for Cape La Croix Creek between miles 0.36 and 8.45 and Walker Branch, miles 0.00 to 2.00. Starting water surface elevations were estimated from actual high water marks reached during the historical floods. Cross section data for the channel and overbank areas were obtained from field surveys and topographic aerial photos with a contour interval of two feet. Mannings roughness coefficients were estimated after field observation and aerial photograph analysis. The "n" values used for channels varied from .035 to .065 and from .020 to .090 for overbank areas. Typical cross sections are shown on PLATES D-9 through D-12. Expansion and contraction coefficients were selected from values recommended in the HEC-2 Users Manual. For gradual transitions 0.3 and 0.1 were used and for abrupt transitions 0.8 to 0.6 were used for expansion and contraction coefficients, respectively. Cape La Croix Creek is crossed by two railroads, 11 streets and highways, one private drive and one footbridge while Walker Branch is crossed by one railroad, 10 streets and roads and three private driveways. Bridge data were obtained from field surveys and from as-built drawings.

VERIFICATION OF MODELS.

8. The storms of 26-27 May 1973 and 27-28 March 1977 were analyzed in detail in an attempt to verify the models.

9. Rainfall data for the two storms were developed for the basin using a combination of Theissen and Isohystal methods, applying the total storm rainfall amounts at the non-recording U.S. Weather Service stations at Cape Girardeau Airport and Jackson, Missouri. In addition, for the 1977 storm, the privately operated local gage which reported 9 inches of rainfall was included as a non-recording station. The rainfall was distributed into hourly amounts, with the use of the U.S. Weather Service recording station at Advance, Missouri. The hourly amounts were further divided into five minute intervals in accordance with the the method presented in NOAA Technical Memorandum NWS - HYDRO-35.

10. Unit hydrographs and runoff hydrographs for the two storms were computed for each of the 25 basins. Then, using the HEC-1 program, the individual hydrographs were combined and routed using the Modified Puls option throughout the system. In the high damage commercial area the peak flow produced by the 1973 storm has about a four percent chance of occurrence on Cape La Croix Creek and about a 10 percent chance on Walker Branch. At the same location, the 1977 storm produced a peak flow with about a two percent chance of occurrence on each of the two streams.

11. Flood hydrographs for the May 1973 and March 1977 storms at several locations are shown in PLATES D-13 through D-16.

12. The HEC-2 model was then used to compute water surface profiles for the computed discharges of the May 1973 and March 1977 floods.

13. The computed water surface profiles were compared to the actual high water marks for both storms. The models were adjusted slightly until acceptable reproductions of the known flood profile were achieved.

A comparison of actual high water marks and computed water surface elevations for Cape La Croix Creek and Walker Branch are given in PLATES D-17 and D-18, respectively.

WATER SURFACE PROFILES

14. The computation of water surface profiles is discussed under the topics of existing conditions, then future conditions synthetic runoff hydrographics and water surface profiles and finally, Mississippi River influence.

EXISTING CONDITIONS.

15. Point rainfall amounts were obtained for the 50, 20, 10, 4, 2, and 1 percent chance storms from Technical Papers 40 and 49 and are shown in TABLE D-3. The rainfall for the .2 percent chance storm was obtained by extrapolation of a rainfall versus frequency curve plotted on log-probability paper. The point rainfall values were first adjusted for annual series and then for depth-area relationship, using areas of 0.1, 5.0, and 25.0 square miles. Consistent runoff hydrographs were computed for all the hypothetical storms by applying the adjusted rainfall amounts to the SCS unit hydrograph ordinates, using the Depth-Area-Stream System Computation (JOPER 4) option of the HEC-1 model. The 10, 2 and 1 percent chance peak discharges computed by the HEC-1 program at several locations were compared to those computed by either of two empirical prediction equations, depending upon the degree of urbanization. For partially or fully urbanized areas, the method developed by E. E. Gann of the U.S.G.S. was used. This method published in 1971 in a report entitled, "Generalized Flood-Frequency Estimates for Urban Areas in Missouri" is applicable for urban drainage areas in Missouri between 0.1 and 50 square miles. For rural or natural areas, the empirical prediction

equations developed by the St. Louis District through regression analyses were used. These equations of the form $Q = C(DA)^x(S)^y$ are considered applicable for natural streams within the St. Louis District, excluding the Mississippi and Illinois Rivers. The results of the flow comparisons are shown in TABLE D-4.

TABLE D-3

RAINFALL FREQUENCY-DEPTH-INTENSITY-DURATION

PERCENT CHANCE OF OCCURRENCE

Duration (Hrs.)	50	20	10	4	2	1	.2
0.083	0.48	0.58	0.68	0.77	0.86	0.93	1.11
0.166	0.74	0.90	1.04	1.19	1.33	1.43	1.70
0.25	0.93	1.14	1.32	1.50	1.68	1.81	2.18
0.50	1.29	1.58	1.83	2.09	2.33	2.51	3.00
1.00	1.59	2.02	2.29	2.63	2.89	3.22	3.83
2.00	1.94	2.42	2.80	3.20	3.52	3.91	4.68
3.00	2.18	2.71	3.10	3.50	3.91	4.32	5.20
6.00	2.65	3.25	3.71	4.29	4.70	5.16	6.08
12.00	3.13	3.83	4.41	4.96	5.59	6.10	7.30
24.00	3.60	4.46	5.10	5.83	6.50	7.10	8.40
48.00	4.15	5.26	6.00	6.42	7.80	8.42	10.00
96.00	4.97	6.25	7.30	8.63	9.50	10.60	12.80
168.00	5.84	7.30	8.30	9.80	10.80	12.15	14.90
240.00	6.35	7.95	9.40	10.80	12.20	13.60	16.70

*Values for the .2 percent chance of occurrence were obtained by extrapolation of rainfall versus percent chance of occurrence curves plotted on log probability paper.

TABLE D-4

FLOW COMPARISONS

Stream	Location	10% Chance Q		2% Chance Q		1% Chance Q	
		HEC-1	*Empirical	HEC-1	*Empirical	HEC-1	*Empirical
1. Cape La Croix Cr.	Above Hwy W	3,700	2,750 (S)	5,700	5,350 (S)	6,800	6,900 (S)
2. Cape La Croix Cr.	Above Hwy 61 (South)	5,200	4,620 (G)	8,600	7,350 (G)	9,900	8,400 (G)
3. Cape La Croix Cr.	Above Bloomfield Rd.	5,700	6,100 (G)	9,800	9,200 (G)	11,100	10,400 (G)
4. Walker Branch	Above Marietta St.	950	966 (G)	1,470	1,560 (G)	1,640	1,702 (G)
5. Walker Branch	Above Mouth	1,790	1,710 (G)	2,340	2,475 (G)	2,620	2,835 (G)

*Two different empirical methods were used, depending on the degree of urbanization. For partially or fully urbanized areas, the E. E. Gann method was used and the values denoted with (G). For rural areas, the St. Louis District equation was used and the values denoted with (S).

16. Water surface profiles were computed for the resulting computed flows for existing conditions using the HEC-2 models. The profiles for the floods with a 10, 2, 1, and .2 percent chance of occurrence were published in the Flood Insurance Study for the city of Cape Girardeau in 1978. Since these profiles differed only slightly from the profiles for future conditions with no project, described later in this Appendix, they are not shown in this report.

FUTURE CONDITIONS, SYNTHETIC RUNOFF HYDROGRAPHS

17. Future land use maps prepared by the Southeast Missouri Regional Planning Commission (SEMO) for the year 1995 were used to modifiy the existing condition models for future conditions without a flood control project. Within the watershed, the 1995 conditions were approximately the same as those for 2020, according to SEMO. The maps indicate that residential and commercial development will spread northward in the Cape La Croix Creek and Walker Branch basins and industrial development will occur in the lower reaches of Cape La Croix Creek. The weighted SCS curve numbers were computed for each subarea for future conditions and are presented in TABLE D-1. Times of concentration were reduced for areas in which urban development was predicted to occur. A comparison of the estimated times of concentration for existing and future conditions is shown in TABLE D-5.

Runoff hydrographs for the storms with a 50, 20, 10, 4, 2, 1, and .2 percent chance of occurrence were computed for future land use conditions using the revised HEC-1 model. The Standard Project Storm runoff hydrogrpahs were computed using the HEC-1 model with a 24 hour duration storm with one hour intervals. The resulting hydrographs were used as a basis of comparison with several alternative plans analyzed.

FUTURE CONDITIONS, WATER SURFACE PROFILES

18. The water surface profiles for the floods with a 50, 20, 10, 4, 2, 1, and .2 percent chance of occurrence, as well as the Standard Project Flood (SPF) were computed for Cape La Croix Creek and Walker Branch, assuming future land use conditions. Profiles for the floods with a 50, 10, 1, and .2 percent chance of occurrence plus the SPF are presented in PLATES D-19 through D-21. The areas flooded by the 10 percent and 1 percent probability floods and the SPF are shown in PLATES D-22 through D-32. The extent of these areas was determined by comparing the computed water surface profiles to the topographic maps. In some cases, individual structures may be shown flooded when in fact the first floor elevation is at an elevation above the contours shown on the map.

TABLE D-5

TIME OF CONCENTRATION (TC)
CAPE LA CROIX CREEK
PRESENT VS. FUTURE CONDITIONS

Basin No.	Slope ft/ft	Exist Cond Tc (Hr.)	Future Cond Tc (Hr.)
10	.0171	1.25	1.2
20	.0163	1.0	.90
30	.0235	.75	.70
40	.0219	.67	.65
50	.0140	1.17	1.1
60	.0240	.58	.5
70	.0243	.58	.5
80	.0213	.67	.60
90	.0209	.67	.60
100	.0143	.42	.40
110	.0235	.25	.25
120	.0202	.33	.33
130	.0157	.25	.25
140	.0278	.17	.17
150	.0244	.50	.50
160	.0218	.50	.50
170	.0175	.33	.33
180	.0174	.25	.25
190	.0248	.33	.33
200	.0229	.42	.40
210	.0106	.42	.40
220	.0194	.25	.25
230	.0250	.33	.25
240	.0122	.83	.75
250	.0134	.67	.60

MISSISSIPPI RIVER INFLUENCE

19. The extent of flooding problems resulting from backwater from the Mississippi River entering Cape La Croix Creek was considered to be minimal, since most of the area flooded is undeveloped or low cost property. Sensitivity tests were made to determine affects of Mississippi backwater on Cape La Croix Creek profiles. Various starting water surface elevations were used in computing the Cape La Croix Creek profiles and for all cases, the backwater effect was dampened out downstream of the commercial area. The flood elevations expected at the confluence of Cape La Croix Creek and the Mississippi River at mile 50.2 are:

.1 Percent Chance Flood	360.0
.2 Percent Chance Flood	358.4
1 Percent Chance Flood	354.0
2 Percent Chance Flood	351.6
4 Percent Chance Flood	349.0
10 Percent Chance Flood	345.8
20 Percent Chance Flood	342.9
50 Percent Chance Flood	334.5

20. The .1, .2, and 50 percent chance flood elevations were determined by extropolating an elevation versus frequency curve obtained from 1974 Mississippi Basin Model results. Where the Mississippi River backwater elevation is higher than the corresponding frequency flood on Cape La Croix Creek, the Mississippi elevation is plotted on the profiles, extending horizontally upstream until it intersects the Cape La Croix Creek profile. The 1 percent chance Mississippi River flood elevation would extend up to mile 1.15 of Cape La Croix Creek. Since a Standard Project Flood has not been determined for the Mississippi River at Cape Girardeau, the Mississippi River flood with a .1 percent chance of occurrence was plotted horizontally up the Cape La Croix Creek profile until it intersected the SPF profile.

ALTERNATIVE SOLUTIONS

21. Development of the final Stage 3 alternatives and selection of the recommended plan is accomplished through an iterative plan formulation process. In the Stage 2 study, emphasis was placed on developing several alternative solutions to problems identified in the Stage I study. In the Stage 3 study, those plans recommended in the Stage 2 study are carried forward and further refined. Emphasis is placed on impact assesssment and evaluation in this stage and a recommended plan is selected.

DEVELOPMENT OF STAGE 2 ALTERNATIVES

22. Several flood control features were considered in the Stage 2 study in an effort to formulate alternative plans to reduce the effects of flooding from Cape La Croix Creek and Walker Branch. These features included various channel improvements, wet reservoirs, dry detention reservoirs, levees, floodwalls, diversions, bridge replacements, and relocation of flood prone structures. Concurrently, other features were being analyzed which would maximize environmental and recreational benefits. Early in the study, levees, floodwalls and diversions were eliminated by study team members due to the lack of space along the stream in the highly developed commercial and residential areas. Because of the severe encroachment upon the creeks, it was decided that concrete lined rectangular channels should be considered in areas where development was most intense. Three channel widths, "small, medium, and large" were selected for the reach of Cape La Croix Creek between mile 2.76 and 3.76 and for Walker Branch between mile 0.00 and 1.11. For the area above mile 3.76 and below mile 2.76 on Cape La Croix Creek and above mile 1.11 on Walker Branch, sufficient space was available for a trapezoidal grass lined channel. Therefore, for each concrete size selected, a trapezoidal grass lined channel was computed with a conveyance equal to the concrete reach. For stability, all grass lined channel improvements were designed with side slopes, of 1 vertical to 3 horizontal. The proposed channel improvements generally follow the existing channel alignments and bottom slopes except for minor smoothing such as at bridge approaches. No channel improvements were considered upstream of mile 5.11 and below mile 0.36 on Cape La Croix Creek and upstream of mile 2.00 on Walker Branch due to the relatively sparse development in those reaches. The smallest concrete channel improvement widths selected were 75 feet on Cape La Croix and 30 feet below and 25 feet above Independence Street on Walker Branch, which are approximately equal to the existing channel widths. Therefore, the channel could be constructed with a minimum of building relocation and bridge replacements. The grass lined channel from mile 0.36 to 2.76 and from mile 3.76 to 5.11 on Cape La Croix Creek was designed with a bottom width of 110 feet. On Walker Branch, a bottom width of 25 feet was used between mile 1.10 and 1.71 with no improvement above mile 1.71. Transitions were used where bridges crossed the improved channels.

23. First, discharges and water surface profiles were computed for future conditions with the smallest sized channel improvements and no bridge replacements, known as Plan 1. After analyzing the profiles, it was noted that bridges at Sprigg Street and Wilson Road on Cape La Croix Creek were creating swellheads. Therefore, discharges and water surface profiles were recomputed with those bridges replaced with clear spans (Plan 3). However, since development was sparse in the area of these bridges, an economic analysis indicated that the costs of the replacements were unjustified. Upon closer analysis of the profiles and economic data, another set of discharges and water surface profiles were

computed with the bridge at Independence Street on Cape La Croix Creek replaced with a clear span. This replacement proved to be economically justified and was included in the channel improvement plan with the smallest channel, Plan 4.

24. The widths selected for the "medium-sized" concrete channel improvements were 100 feet on Cape La Croix Creek and 60 feet below and 50 feet above Independence Street on Walker Branch. The corresponding grass lined channels on Cape La Croix Creek were designed with a bottom width of 160 feet between miles 0.36 and 2.76 and between miles 3.76 and 5.11. The grass lined channels on Walker Branch were designed with a bottom width of 75 feet between miles 1.10 and 1.71 and 35 feet between miles 1.71 and 2.00. Because the bridges at Sprigg Street, Wilson Road and Independence Street on Cape La Croix Creek and Good Hope, William, Town Plaza Driveway, Independence, Themis, private driveway, Bessie, and Marietta Streets created constrictions in the improved channel design all were removed and all were replaced with clear spans. Discharges and water surface profiles were computed for this medium sized channel improvement called Plan 2. Economic analysis showed that this plan was not justified. Since little benefits were being gained by channel improvements below the commercial district, a medium sized channel improvement plan with no channel improvements or bridge replacements between the mouth and mile 2.76 on Cape La Croix Creek was analyzed. Again the discharge and water surface profiles were computed. The result was an economically justified channel improvement plan, called Plan 6.

25. The third or "large" concrete channel improvement size considered was a rectangular channel 125 feet wide on Cape La Croix and 100 feet wide on Walker Branch. On Cape La Croix Creek, a trapezoidal grass lined channel with a bottom width of 160 feet was used between miles 0.36 and 2.76 and between miles 3.76 and 5.11. A bottom width of 150 feet was used for the trapezoidal earth channel on Walker Branch between miles 1.10 and 1.71 and 50 feet between miles 1.71 and 2.00. All 17 bridges in the improved channel reaches would be removed and replaced. In addition, several buildings would need to be relocated to provide sufficient right of way for the improvement. After computing the discharges and the water surface profiles, and economic analysis proved the plan (Plan 5) economically unfeasible.

26. The next feature to be considered was reservoirs. Early in the Stage 2 study, the Study Coordinator met with a representative of the newly formed Cape La Croix Creek Drainage District. Mutually, they selected several possible reservoir sites in the upper portions of the Cape La Croix Creek basin. However, after maps and field reconaissance by team members, wet reservoirs and all but one dry detention site were ruled out due to development and location of major roads in the vicinity. The selected dry detention site is located on a tributary stream about 1.05 miles above its confluence with Cape La Croix Creek at mile 7.2. The structure consists of an earth filled dam with a low level

outlet pipe and a spillway which will pass flows which exceed the storage capacity of the reservoir. A 54 inch CMP low level outlet pipe was selected since the flow from the outlet is approximately one half the downstream channel capacity. The Dam Safety version of the hydrologic model, HEC-1DB, was used to determine the spillway crest elevations required to store the storms with a 10, 2, and 1 percent chance of occurrence and the Standard Project Storm. The model was first run with the low level outlet in place and the spillway and top of dam elevations set very high so as not to overtop. The elevation of the 100 foot wide spillway was then set equal to the maximum ponding elevation for each of the respective storms. Then, the Probable Maximum Flood was routed through each reservoir size with the top of dam set very high. The top of dam was computed for each reservoir size by adding four feet of elevation to the resulting maximum pool elevations to insure against any overtopping.

27. The multi-plan version of HEC-1 was then used to compute the full range of frequency discharges throughout the basin with the various size reservoirs in place. Using these discharges, water surface profiles were computed with the HEC-2 model for each reservoir. It was found that the most economical reservoir was the one with the capacity to store the 10-year storm. This flood control plan consisting of one dry detention reservoir was labelled Plan 8 in the Stage 2 study.

28. Since there were now an economically justified channel improvement plan (Plan 6) and an economically justified dry detention reservoir plan (Plan 8), the next step was to combine the two features which was called Plan 7. Discharges and water surface profiles were again computed with both features in place and after economic analyses were performed, it was found that this plan also provided for an economically justified flood control alternative.

29. One of the goals for the Stage 2 study was to investigate the feasibility of providing protection from the Standard Project Flood (SPF). In an attempt to achieve this high degree of protection, features of the largest practical channel improvement (Plan 5) were added to the largest dry detention reservoir (SPF) considered in Plan 8). Together, the plan was called Plan 9 but failed to provide SPF protection and was not economically justified.

30. Another of the goals was to develop a non-structural plan which could provide a minimum of 10-year protection. This plan, known in Stage 2 as Plan 10, consisted of relocating all structures damaged by the flood with a 10 percent chance of occurrence, but was both economically unjustified and locally unacceptable.

31. Plans 11 and 12 were developed as single purpose plans which maximized environmental and recreational benefits, respectively. Recreational features included hiking and bicycling trails, parks and

picnic areas. Some of the environmental features were corridors along the streams for wildlife, wetland and bottomland preservation, removal of debris from streams and installation of fish habitat structures.

32. After the 12 alternative single purpose plans were developed, four flood control plans (Plans 6, 7, 9 and 10) were selected. Compatible elements of the recreational and environmental plans (Plans 11 and 12) were added to these to create multi-purpose Plans 13, 14, 15 and 16. These four plans plus the single purpose non-structural plan (Plan 10) were selected to be carried forward for more detailed study in Stage 3. Features of all of the Stage 2 plans are shown in Table D-6.

TABLE D-6
FEATURES OF STAGE 2 PLANS 1-15

	PLAN 1			PLAN 2			PLAN 3			PLAN 4			PLAN 5		
	Bottom Width	Lining	Side Slopes	Bottom Width	Lining	Side Slopes	Bottom Width	Lining	Side Slopes	Bottom Width	Lining	Side Slopes	Bottom Width	Lining	Side Slopes
CHANNEL IMPROVEMENTS BY STREAM MILE															
Cape La Croix Creek															
.360 - .400	110	Grass	3:1	160	Grass	3:1	110	Grass	3:1	110	Grass	3:1	160	Grass	3:1
.400 - 1.215	110	Grass	3:1	160	Grass	3:1	110	Grass	3:1	110	Grass	3:1	160	Grass	3:1
1.215 - 1.850	110	Grass	3:1	160	Grass	3:1	110	Grass	3:1	110	Grass	3:1	160	Grass	3:1
1.850 - 2.870	110	Grass	3:1	160	Grass	3:1	110	Grass	3:1	110	Grass	3:1	160	Grass	3:1
2.870 - 3.760	75	Conc.	0	100	Conc.	0	75	Conc.	0	75	Conc.	0	125	Conc.	0
3.760 - 4.090	110	Grass	3:1	160	Grass	3:1	110	Grass	3:1	110	Grass	3:1	160	Grass	3:1
4.090 - 5.113	110	Grass	3:1	160	Grass	3:1	110	Grass	3:1	110	Grass	3:1	160	Grass	3:1
Walker Branch															
0.030 - 0.403	30	Conc.	0	60	Conc.	0	30	Conc.	0	30	Conc.	0	100	Conc.	0
0.403 - 0.510	25	Conc.	0	50	Conc.	0	25	Conc.	0	25	Conc.	0	100	Conc.	0
0.510 - 0.860	25	Conc.	0	50	Conc.	0	25	Conc.	0	25	Conc.	0	100	Conc.	0
0.860 - 1.100	25	Conc.	0	50	Conc.	0	25	Conc.	0	25	Conc.	0	100	Conc.	0
1.100 - 1.460	25	Grass	3:1	75	Grass	3:1	25	Grass	3:1	25	Grass	3:1	150	Grass	3:1
1.460 - 1.710	25	Grass	3:1	75	Grass	3:1	25	Grass	3:1	25	Grass	3:1	150	Grass	3:1
1.710 - 2.000				35	Grass	3:1							50	Grass	3:1
CAPE LA CROIX CREEK BRIDGES															
Sprigg Street					Replace			Replace						Replace	
Wilson Road					Replace			Replace						Replace	
Bloomfield Street														Replace	
Highway 61														Replace	
Independence Street					Replace						Replace			Replace	
E. Rodney Street														Replace	
WALKER BRANCH BRIDGES															
Good Hope Street					Replace									Replace	
William Street					Replace									Replace	
Town Plaza Drive					Replace									Replace	
Independence Street					Replace									Replace	
Missouri Pacific Railroad														Replace	
Themis Street					Replace									Replace	
Private Drive					Replace									Replace	
Bessie Street					Replace									Replace	
Broadway														Replace	
Kingsway														Replace	
Marietta Street					Replace									Replace	
DRY DETENTION RESERVOIR SIZE															

TABLE D-6
(Continued)

	PLAN 6			PLAN 7			PLAN 8			PLAN 9			PLAN 10		
	Bottom Width	Lining	Side Slopes	Bottom Width	Lining	Side Slopes	Bottom Width	Lining	Side Slopes	Bottom Width	Lining	Side Slopes	Bottom Width	Lining	Side Slopes
CHANNEL IMPROVEMENTS BY STREAM MILE															
Cape La Croix Creek															
3.60 - .400										160	Grass	3:1	(Non-Structural Plan		
.400 - 1.215										160	Grass	3:1	- No Flood Control		
1.215 - 1.850										160	Grass	3:1	Features)		
1.850 - 2.760										160	Grass	3:1			
2.760 - 3.760	100	Conc.	0	100	Conc.	0				125	Conc.	0			
3.760 - 4.090	160	Grass	3:1	160	Grass	3:1				160	Grass	3:1			
4.090 - 5.113	160	Grass	3:1	160	Grass	3:1				160	Grass	3:1			
Walker Branch															
0.030 - 0.403	60	Conc.	0	60	Conc.	0				100	Conc.	0			
0.403 - 0.510	50	Conc.	0	50	Conc.	0				100	Conc.	0			
0.510 - 0.860	50	Conc.	0	50	Conc.	0				100	Conc.	0			
0.860 - 1.100	50	Conc.	0	50	Conc.	0				100	Conc.	0			
1.100 - 1.460	75	Grass	3:1	75	Grass	3:1				150	Grass	3:1			
1.460 - 1.710	75	Grass	3:1	75	Grass	3:1				150	Grass	3:1			
1.710 - 2.000	35	Grass	3:1	35	Grass	3:1				50	Grass	3:1			
CAPE LA CROIX CREEK BRIDGES															
Sprigg Street											Replace				
Wilson Road											Replace				
Bloomfield Street											Replace				
Highway 61											Replace				
Independence Street		Replace			Replace						Replace				
E. Rodney Street											Replace				
WALKER BRANCH BRIDGES															
Good Hope Street		Replace			Replace						Replace				
William Street		Replace			Replace						Replace				
Town Plaza Drive		Replace			Replace						Replace				
Independence Street		Replace			Replace						Replace				
Missouri Pacific Railroad											Replace				
Themis Street		Replace			Replace						Replace				
Private Drive		Replace			Replace						Replace				
Bessie Street		Replace			Replace						Replace				
Broadway											Replace				
Kingsway											Replace				
Marietta Street		Replace			Replace						Replace				
DRY DETENTION RESERVOIR SIZE					10 Year			10 Year			SPF				

TABLE D-6
(Continued)

	PLAN 11			PLAN 12			PLAN 13			PLAN 14			PLAN 15		
	Bottom Width	Lining	Side Slopes	Bottom Width	Lining	Side Slopes	Bottom Width	Lining	Side Slopes	Bottom Width	Lining	Side Slopes	Bottom Width	Lining	Side Slopes
CHANNEL IMPROVEMENTS BY STREAM MILE															
Cape La Croix Creek															
.360 - .400	(Environmental Plan - No Flood Control Features)			Recreation Plan - No Flood Control Features)									160	Grass	3:1
.400 - 1.215													160	Grass	3:1
1.215 - 1.850													160	Grass	3:1
1.850 - 2.760													160	Grass	3:1
2.760 - 3.760							100	Conc.	0	100	Conc.	0	125	Conc.	0
3.760 - 4.090							160	Grass	3:1	160	Grass	3:1	160	Grass	3:1
4.090 - 5.113							160	Grass	3:1	160	Grass	3:1	160	Grass	3:1
Walker Branch															
0.030 - 0.403							60	Conc.	0	60	Conc.	0	100	Conc.	0
0.403 - 0.510							50	Conc.	0	50	Conc.	0	100	Conc.	0
0.510 - 0.860							50	Conc.	0	50	Conc.	0	100	Conc.	0
0.860 - 1.100							50	Conc.	0	50	Conc.	0	100	Conc.	0
1.100 - 1.460							75	Grass	3:1	75	Grass	3:1	150	Grass	3:1
1.460 - 1.710							75	Grass	3:1	75	Grass	3:1	150	Grass	3:1
1.710 - 2.000							35	Grass	3:1	35	Grass	3:1	50	Grass	3:1
CAPE LA CROIX CREEK BRIDGES															
Sprigg Street														Replace	
Wilson Road														Replace	
Bloomfield Street														Replace	
Highway 61														Replace	
Independence Street								Replace			Replace			Replace	
E. Rodney Street														Replace	
WALKER BRANCH BRIDGES															
Good Hope Street								Replace			Replace			Replace	
William Street								Replace			Replace			Replace	
Town Plaza Drive								Replace			Replace			Replace	
Independence Street								Replace			Replace			Replace	
Missouri Pacific Railroad														Replace	
Themis Street								Replace			Replace			Replace	
Private Drive								Replace			Replace			Replace	
Bessie Street								Replace			Replace			Replace	
Broadway														Replace	
Kingsway														Replace	
Marietta Street								Replace			Replace			Replace	
DRY DETENTION RESERVOIR SIZE											10 Year			SPF	

DEVELOPMENT OF STAGE 3 ALTERNATIVES

DRY DETENTION STORAGE

33. Only one dry detention site was found to be economically feasible during earlier studies and it was carried forward and used in the final analysis. However, one result of the high degree of local interest in dry detention storage was that an additional effort was spent in analyzing other favorable sites during the final analysis.

34. The first of these sites was suggested by a member of the local Drainage District at the Stage 2 Public Meeting. This site was designated site 1A and is located on Cape La Croix Creek just upstream of Highway 61-34, near the northern city limits of Cape Girardeau. Due to the length of fill required and the cost of relocating Route W, the site would not be economically feasible. Therefore, the site was eliminated from further detailed analyses.

35. A broader search for potential detention sites was then accomplished. The hydrologic model was examined to determine which of the subareas were significantly contributing to the peak flows of either Cape La Croix Creek or Walker Branch. Once these were identified, topographic maps and aerial photographs were used to select the most favorable potential sites. Factors considered in the analysis included size of catchment area, topography, and amount of development including roads, streets, utilities, etc. These sites are shown on Plate D-33. Site 2 was located at stream mile 8.84 on the main stem of Cape La Croix Creek. Site 3 was on an unnamed tributary which enters Cape La Croix Creek just upstream of the intersection of Highway 61-34 and Route W. Sites 4 and 5 were located in the upper reaches of Walker Branch. At each of the sites a low level outlet size was selected based on downstream channel capacity. Spillway widths were selected for each site, based on existing topography. Low level outlet sizes, invert elevations, and spilllway widths are presented in TABLE D-7.

TABLE D-7
CAPE LA CROIX CREEK AND WALKER BRANCH

Dry Detention Reservoir Features

Dry Detention Site No.	Low Level Outlet Diam. (In.)	Low Level Outlet Elev.	Spillway Width (ft.)
1	54	405	100
2	60	429.5	100
3	42	381	50
4	42	417	50
5	42	441	50
6	48	499	100

Each dry detention reservoir site was analyzed independent of any other flood control component. HEC-1DB was used to determine the spillway crest elevations required to store the storms with a 10, 2, 1, and .02 percent chance of occurrence at each of the sites. First, the spillway crest elevation was assumed to be very high and each of the hypothetical storms was routed through the detention reservoir. The spillway crest elevations were then set equal to the maximum pool elevation for each of the respective storms. Next, the Probable Maximum Flood (PMF) was routed through each of the four reservoir sizes with the top of dam elevation set very high. The actual top of dam was then established by adding four feet to the resulting maximum pool elevations to insure against overtopping. Therefore at each site, dry detention reservoirs with four storage capacities, spillway crests, and top of dam elevations were analyzed.

36. The dry detention reservoir at Site 2 was effective in reducing peak flows in the high damage reaches of Cape La Croix Creek. A benefit-cost analysis indicated that the reservoir with capacity to store the storm with a 10 percent chance of occurrence was the optimum size reservoir. This feature was economically justified and was therefore included as a component in the analyses of alternative plans.

37. Although the dry detention reservoir at Site 3 reduced peak flows from subarea 70, the peak discharge was delayed long enough to allow more flow to be added to the peak hydrograph of Cape La Croix Creek than if no reservoir were included. Therefore, the dry detention reservoir at Site 3 was eliminated from further consideration.

38. Dry detention reservoirs at Sites 4 and 5 were ineffective in reducing peak flows in the high damage reaches of Walker Branch. Also, recent residential developments in the vicinity of the two sites made costs prohibitive. Therefore, no further consideration was given to dry detention reservoirs at Sites 4 and 5.

39. Subsequently, at the request of the local Drainage District, three more sites (6, 7, and 8) were investigated for dry detention storage by team members. Dry detention Site 6, located upstream of Site 2 on the

main stem of Cape La Croix Creek, was analyzed as an alternative to Site 2 since residential development was expected at the latter. However, Site 6 was not as effective in reducing peak flows and a benefit-cost analysis showed that it was not economically justified.

40. Site 7, located just upstream of Hopper Road on Cape La Croix Creek is an area that presently acts as a natural flood storage area due to the Hopper Road fill and small bridge opening. The bottomland is primarily undeveloped but is bounded by Mt. Auburn Road on the west, Highway 61-34 on the north, and residential development including Hawthorn School on the east. After reviewing topographic maps and aerial photographs of Site 7, team members determined that the site was not a feasible location for a dry detention reservoir due to the costs involved in raising Mt. Auburn Road and Highway 61-34, and in protecting several homes and commercial structures that would be periodically inundated as a result of the reservoir.

41. Site 8, located immediately upstream of Route W on Cape La Croix Creek was similarly reviewed by team members and was eliminated due to the costs involved in raising or protecting Route W, relocation of several residences and a sewage treatment plant for a large nursing home complex.

CHANNEL IMPROVEMENTS

42. Alternative solutions utilizing the full range of potential channel improvements, including various combinations, were considered. The channel improvements that provided the best flood control performance included concrete, riprap, and grass lined channels. Both trapezoidal and vertical walled channel improvement configurations were considered. The impacts of the various channel types and sizes were also analyzed in combination with the other flood management measures discussed later herein.

NON-STRUCTURAL MEASURES

43. Non-structural features considered in formulating plans included the removal of floodprone structures, floodproofing, elevating structures, low floodwalls or levees, flood hazard warning and flood plain zoning.

OTHER MANAGEMENT MEASURES

44. Other flood control features which were considered include levees, floodwalls and diversions. Because of the severe encroachment upon the streams and the numerous crosings in the commercial and residential areas, levees and floodwalls were not considered to be feasible alternatives. Also, no feasible flow diversion alternative was found.

COMBINATIONS

45. Those measure which appeared to be viable flood control measures were used as a basis to create the NED, EQ, SPF, Plan A, Non-Structural and Recommended Plans. The development of these plans is an iterative process which is discussed in the paragraphs that follow with the results of those iterations shown on TABLES D-8, and D-9.

NATIONAL ECONOMIC DEVELOPMENT (NED) PLAN

46. The NED plan was developed by dividing flood control features into separable economic and hydraulic elements. Each element was then selected fundamentally on its ability to maximize net tangible benefits. Additionally, the planning constraints previously listed required that the final array of alternatives, including the NED plan, be implementable and workable plans.

TABLE D-8
COMPARISON OF STAGE 3 ALTERNATIVES

FLOOD CONTROL FEATURES	Alternate 1			Alternate 2			Alternate 3			Alternate 4			Alternate 5			Alternate 6		
	Bot. Wid. (FT.)	Lining	Side Slope (H:V)	Bot. Wid. (FT.)	Lining	Side Slope (H:V)	Bot. Wid. (FT.)	Lining	Side Slope (H:V)	Bot. Wid. (FT.)	Lining	Side Slope (H:V)	Bot. Wid. (FT.)	Lining	Side Slope (H:V)	Bot. Wid. (FT.)	Lining	Side Slope (H:V)
CHANNEL IMPROVEMENTS BY STREAM MILE																		
CAPE LA CROIX CREEK																		
Mile 0.00 - 2.72		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.76 - 2.76		-		T	Conc	-	T	Conc	-	T	Conc	-	T	Conc	-	T	Conc	-
2.76 - 3.14		-		75	Conc	0	75	Conc	0	75	Conc	0	100	Conc	0	75	Conc	0
3.14 - 3.23		-		T	Conc	-	75	Conc	0	T	Conc	-	100	Conc	0	75	Conc	0
3.23 - 3.30		-		T	Conc	-	75	Conc	0	T	Conc	-	100	Conc	0	75	Conc	0
3.33 - 3.76		-			-		75	Conc	0		-		100	Conc	0	75	Conc	0
3.76 - 3.80		-			-		T	Conc	-		-		T	Conc	-	T	Conc	-
3.80 - 5.11		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WALKER BRANCH																		
Mile 0.00 - 0.08		-		30	Conc.	0	T	Conc.	-	60	Conc.	0	T	Conc.	-	60	Conc.	0
0.08 - 0.40		-		30	Conc.	0		-		60	Conc.	0		-		60	Conc.	0
0.40 - 0.89		-		25	Conc.	0		-		50	Conc.	0		-		50	Conc.	0
0.89 - 0.96		-		T	Conc.	-		-		T	Conc.	-		-		T	Conc.	-
0.96 - 1.10		-		25	Grass	3:1		-		75	Grass	3:1		-		75	Grass	3:1
1.10 - 1.68		-		25	Grass	3:1		-		75	Grass	3:1		-		75	Grass	3:1
1.68 - 1.74		-		T	Riprap	-		-		T	Riprap	-		-		T	Riprap	-
1.74 - 2.00		-			-			-		35	Grass	3:1		-		35	Grass	3:1
DETENTION RESERVOIR		YES			YES			YES			YES			YES			YES	

TABLE D-8 CONT'D)
COMPARISON OF STAGE 3 ALTERNATIVES

FLOOD CONTROL FEATURES	Alternate 7 Bot. Wid. (FT.)	Alternate 7 Lining	Alternate 7 Side Slope (H:V)	Alternate 8 Bot. Wid. (FT.)	Alternate 8 Lining	Alternate 8 Side Slope (H:V)	Alternate 9 Bot. Wid. (FT.)	Alternate 9 Lining	Alternate 9 Side Slope (H:V)	Alternate 10 Bot. Wid. (FT.)	Alternate 10 Lining	Alternate 10 Side Slope (H:V)	Alternate 11 Bot. Wid. (FT.)	Alternate 11 Lining	Alternate 11 Side Slope (H:V)	Alternate 12 Bot. Wid. (FT.)	Alternate 12 Lining	Alternate 12 Side Slope (H:V)
CHANNEL IMPROVEMENTS BY STREAM MILE																		
CAPE LA CROIX CREEK																		
Mile 0.00 - 2.72		-			-			-			-			-			-	
2.76 - 2.76	T	Conc	-	T	Conc	-	T	Conc	-	T	Conc	-	T	Conc	-	T	Conc	-
2.76 - 3.14	75	Conc	0	100	Conc	0	100	Conc	0	75	Conc	0	75	Conc	0	75	Conc	0
3.14 - 3.23	75	Conc	0	T	Conc	-	100	Conc	0	T	Conc	-	T	Conc	-	T	Conc	-
3.23 - 3.30	75	Conc	0	T	Conc	-	100	Conc	0	40	Riprap	2.5:1	40	Riprap	2.5:1	40	Riprap	2.5:1
3.33 - 3.76	75	Conc	0		-		100	Conc	0	40	Riprap	2.5:1	40	Riprap	2.5:1	40	Riprap	2.5:1
3.76 - 3.80	T	Conc	-		-		T	Conc	-	T	Riprap	-	T	Riprap	-	T	Riprap	-
3.80 - 5.11	110	Grass	3:1		-		160	Grass	3:1		-			-			-	
WALKER BRANCH																		
Mile 0.00 - 0.08	60	Conc.	0	100	Conc.	0	60	Conc.	-	60	Conc.	0	60	Conc.	0	60	Conc.	0
0.08 - 0.40	60	Conc.	0	100	Conc.	0	60	Conc.	-	60	Conc.	0	60	Conc.	0	60	Conc.	0
0.40 - 0.89	50	Conc.	0	100	Conc.	0	50	Conc.	-	50	Conc.	0	50	Conc.	0	50	Conc.	0
0.89 - 0.96	T	Conc	-	T	Conc	-	T	Conc	-	50	Conc	0	T	Conc	-	T	Conc	-
0.96 - 1.10	75	Grass	3:1	150	Grass	3:1	75	Grass	3:1	50	Conc	0	75	Grass	3:1		-	
1.10 - 1.68	75	Grass	3:1	150	Grass	3:1	75	Grass	3:1	75	Grass	3:1	75	Grass	3:1		-	
1.68 - 1.74	T	Riprap	-	T	Riprap	-	T	Riprap	-	T	Riprap	-	T	Riprap	-		-	
1.74 - 2.00	35	Grass	3:1	50	Grass	3:1	35	Grass	3:1	35	Grass	3:1	35	Grass	3:1		-	
DETENTION RESERVOIR		YES			YES			YES			YES			YES			YES	

47. Of the flood control features evaluated in earlier studies the one which best maximized net benefits was selected as the basis for the NED alternative. This feature was the dry detention reservoir at site 1, with capacity to store the 10-year storm before overtopping the spillway. Additional analyses were performed to more accurately determine the channel improvement elements which when added to the dry detention reservoir, would best maximize net benefits. In addition to the small, medium and large size channel improvements, a smaller size improvement with riprap lining was also studied to insure identification of the best NED alternative. The hydrologic and hydraulic models were used to compute discharge hydrographs and water surface profiles for each channel improvement system on Cape La Croix Creek and Walker Branch for the full range of recurrence intervals. Average annual benefits and costs were computed for each alternative. The flood control features for each of the 12 alternatives are shown in TABLE D-8. The results indicated that the alternative which best maximized net benefits was the combination of a dry detention reservoir on Cape La Croix Creek and channel improvements on both Cape La Croix Creek and Walker Branch, shown as Alternative 11 on TABLE D-8. The flood control features in this plan were selected for the NED plan improvement. On Cape La Croix Creek, the channel features consist of a 75 feet wide rectangular concrete channel from mile 2.76 to 3.14 and a 40 feet wide trapezoidal riprap lined channel from mile 3.23 to 3.76 with appropriate transition sections at the downstream and upstream ends of the improvement and at the change in channel section. Channel improvements for the segments below 2.72 and above 3.80 were found to be economically infeasible. On Walker Branch, the channel improvement features consist of a rectangular concrete channel 60 feet wide between the mouth and Independence Street (mile 0.40) and 50 feet wide from there to Kingsway Street (mile 0.89). Also, included is a trapezoidal grass lined channel 75 feet wide between miles 0.96 and 1.68, and 35 feet wide between miles 1.74 and 2.00. Appropriate transition sections connect the various channel improvement segments. Several bridge replacements were included as part of the channel improvement features. Flood control features of all of the Stage 3 Plans are displayed in TABLE D-9. To these flood control features were added recreational features described elsewhere in the report. Only those recreational features which had positive net benefits were included in the NED plan. The effect of the NED plan on the discharge-frequency and stage frequency relationships is described later in this appendix under the heading "Recommended Plan".

PLAN A

58. In order to present a wider array of alternatives, a plan which provided for greater flood protection was selected from TABLE D-8. This plan, shown as alternative 7 on the table was named Plan A and was carried to the final array of plans. Plan A consists of a dry detention reservoir, channel improvements on both Cape La Croix Creek and Walker Branch, relocation of two low-lying residential areas and selected environmental and recreational facilities. The dry detention reservoir

is the same as the NED dry detention reservoir at Site 1. Channel improvements on Cape La Croix Creek include a 75 feet wide rectangular concrete channel from mile 2.76 to 3.76, and a grass lined trapezoidal channel with a bottom width of 110 feet and side slopes of 3:1 from mile 3.80 to 5.11 with appropriate transition sections. Channel improvments on Walker Branch consist of a 60 feet wide rectangular concrete channel from 0.00 to 0.40, a 50 feet wide rectangular concrete channel from mile 0.40 to 0.89, a trapezoidal grass lined channel, with a bottom width of 75 feet and side slopes of 3:1 from mile 0.96 to 1.68, and a trapezoidal grass lined channel with a bottom width of 35 feet and side slopes of 3:1 from mile 1.74 to 2.00. Appropriate transition sections connect the various channel improvement sections. As in the NED plan, several bridges were replaced along Walker Branch and are listed in TABLE D-9. Since substantial damages would still be sustained by the low lying residential areas along Sprigg Street near mile 0.40 of Cape La Croix Creek and the Golliday Subdivision near mile 0.90 of Walker Branch, Plan A included the relocation of the residents and razing of the structures. Environmental and recreational features, described elsewhere in the report were added to Plan A. Since many of the flood control features are identical to the NED plan, the effect of this plan on the discharge-frequency relationship was very similar to that of the NED plan. However, due to the increased channel carrying capacity of Cape La Croix Creek water surface profiles were further reduced in this plan. PLATES 88, 89 and 90 show water surface profiles for Cape La Croix Creek and Walker Branch with Plan A improvements, compared to water surface profiles with no improvement.

ENVIRONMENTAL QUALITY (EQ) PLAN

49. Plan A was selected as the basis for the EQ Plan in an effort to develop an implementable plan which would accomplish the major project goal of flood control while maximizing environmental benefits. Since the EQ Plan consists of the same flood control features as Plan A plus environmental and recreational features which would have no significant effect on flood discharges or profiles, the hydrographs, discharge frequency curves and water surface profiles for Plan A would also apply to the EQ Plan. The EQ Plan is described in detail in APPENDIX F.

NON-STRUCTURAL PLAN

50. The non-structural plan of removing the structures damaged by the flood with a 10 percent chance of occurrence was carried forward from the Stage 2 study. This flood was selected as the minimum desired degree of protection. Other non-structural alternatives such as flood proofing, raising of structures, low flood walls or levees and zoning were considered in the Stage 3 study. Due to the depth and rapidity of flooding, the type of construction and access required for the many commercial establishments, the most feasible alternative appeared to be

the removal of 123 commercial and 131 residences. However, the non-structural plan was not economically justified and was unacceptable to locals due to the large number of businesses and residences that would be affected. Plans with a greater degree of protection would force the relocation of even more structures. However, for some sites, the acquisition and razing of structures and relocation of residents was found to be a feasible solution and was incorporated in other plans. Discharge hydrographs, discharge frequency curves, water surface profiles, and stage frequency curves for the future conditions with no project would apply for the non-structural plan as well. The non-structural plan is described in Appendix B. Areas flooded by the flood with a 10 percent chance of occurrence can be found on PLATES D-22 through D-32.

THE STANDARD PROJECT FLOOD (SPF) PLAN

51. Plan 9, consisting of the largest practical channel improvements on Cape La Croix Creek and Walker Branch plus the largest dry detention reservoir at Site 1, was carried forward from the Stage 2 study. To these features was added the dry detention reservoir at Site 2, capable of storing the flood with a 0.2 percent chance of occurrence. This plan resulted in the best overall degree of protection with about a 97 percent reduction in total damages, but fell short of SPF protection. The plan was not economically feasible nor was it acceptable to the locals due to the large number of building relocations and bridge replacements required. Discharge hydrographs for future conditions with the SPF plan in place are shown in PLATES D-40 through D-45. A comparison of discharge-frequency relationships for future conditions with and without the SPF plan are shown on PLATES D-46 through D-51. Water surface profiles for the floods with a 50, 10, 1 and 0.2 percent chance of occurrence and the SPF are presented in PLATES D-52 through D-54.

RECOMMENDED PLAN FEATURES

52. The recommended plan consists of the flood control and recreational features of the NED plan plus non-structural measures and additional recreational features.

RECOMMENDED DRY DETENTION RESERVOIR

53. The recommended dry detention reservoir is located at Site 1 and is designed to store the runoff from a storm with a 10 percent chance of occurrence before overflowing the spillway. The reservoir storage-elevation curve is shown on Plate D-55. The spillway crest is designed to be a broad-crested weir 100 feet wide at elevation 430.5 with a "C" value of 2.7. The spillway is designed to pass the Probable Maximum Flood, assuming that it occurs 5 days after the Standard Project Flood, without overtopping the dam. The top of dam is set at elevation 446.3, four feet above the maximum water surface elevation of the pool.

The 54 inch CMP low level outlet which will allow the reservoir to drain, has its invert at elevation 405.0. The concrete lined spillway chute and stilling basin with 19 baffle piers is designed for a Type III basin in accordance with the Bureau of Reclamation Publication, "Hydraulic Design of Stilling Basins and Energy Dissipators." The stilling basin is 48.5 feet long with a riprap lined transition that extends 330 feet downstream from the end sill of the stilling basin. A sketch of the dam and spillway is shown on PLATE E-13 of Appendix E.

RECOMMENDED CHANNEL IMPROVEMENTS

54. The recommended channel improvement on Cape La Croix Creek consists of a rectangular concrete channel, 75 feet wide extending from mile 2.76 to 3.14 and a trapezoidal riprap lined channel from mile 3.23 to 3.76. The trapezoidal channel has a bottom width of 40 feet and side slopes of 1 vertical to 2.5 horizontal. Riprap sizes were designed to withstand velocities for the one percent chance flood using WES Hydraulic Design Criteria, Volume 2, published by the Waterways Experiment Station, Vicksburg, Mississippi. A concrete lined transition is required at the downstream end of the concrete channel (mile 2.72 - 2.76), and a riprap lined transition is required at the upstream (mile 3.76 - 3.80) end of the riprap channel, and from mile 3.14 to 3.23 where the channel section changes from a rectangular to a trapezoidal section. Transitions for all channel improvements were designed as a wedge type transition using EM 1110-2-1601, Appendix III. No channel improvements are planned for the reach below mile 2.72 or above mile 3.80. It was assumed that the bridge at Independence Street would be replaced with a clear span of 75 feet by the City of Cape Girardeau. On Walker Branch, the concrete channel improvement extends from the mouth up to Kingsway Street at mile 0.89. The channel width is 60 feet between the mouth and Independence Street at mile 0.40, and 50 feet between Independence and Kingsway Streets. A grass lined trapezoidal channel with a bottom width of 75 feet and 1 vertical to 3 horizontal side slopes, extends from mile 0.96 up to mile 1.68. From mile 1.74 to Perryville Road at mile 2.00, the recommended grass lined channel has a bottom width of 35 feet with side slopes of 1 veritcal to 3 horizontal. A concrete lined transition is required from mile 0.89 to 0.96 to change the channel section from rectangular to trapezoidal. A riprap lined transition is used to connect the two trapezoidal channels between miles 1.68 and 1.74. Bridge replacements required by the improvement include Good Hope Street, William Street, Town Plaza driveway, Independence Street, Themis Street, Private Driveway, Bessie Street and Marietta Street. Riprapped transitions are required at the Missouri Pacific Railroad, Broadway Street, Kingsway Street, Lombardo Street and Perryville Road. Mannings roughness coefficients used in the recommended plan model were 0.015 for concrete, 0.035 for riprap and 0.030 for grass lined channels Overbank roughness coefficients varied between 0.020 and 0.090.

TABLE D-9
FLOOD CONTROL FEATURES OF STAGE 3 PLANS

FEATURE	NED PLAN			NON-STRUCT PLAN			PLAN A			EQ PLAN			SPF PLAN			RECOMMENDED PLAN		
1. CHANNEL IMPROVEMENTS	Bot. Wid. (FT.)	Channel Lining	Side Slope (H:V)	Bot. Wid. (FT.)	Channel Lining	Side Slope (H:V)	Bot. Wid. (FT.)	Channel Lining	Side Slope (H:V)	Bot. Wid. (FT.)	Channel Lining	Side Slope (H:V)	Bot. Wid. (FT.)	Channel Lining	Side Slope (H:V)	Bot. Wid. (FT.)	Channel Lining	Side Slope (H:V)
A. Cape La Croix Creek																		
Mile 0.00 - 2.72		-			-			-			-			-			-	
2.72 - 2.76	T	Conc	-		-		T	Conc	-	T	Conc	-	T	Conc	-	T	Conc	-
2.76 - 3.14	75	Conc	0		-		75	Conc	0	75	Conc	0	125	Conc	0	75	Conc	0
3.14 - 3.23	T	Conc	-		-		75	Conc	0	75	Conc	-	125	Conc	0	T	Conc	0
3.23 - 3.76	40	Riprap	2.5:1		-		75	Conc	0	75	Conc	-	125	*Conc*	*0*	40	*Riprap*	2.5:1
3.76 - 3.80	T	Riprap	-		-		T	Conc	-	T	Conc	-	T	Conc	-	T	Riprap	-
3.80 - 5.11		-			-		110	Grass	3:1	110	Grass	3:1	160	Grass	3:1		-	
B. Walker Branch																		
Mile 0.00 - 0.40	60	Conc.	0		-		60	Conc.	0	60	Conc.	0	100	Conc.	0	60	Conc.	0
0.40 - 0.89	50	Conc.	0		-		50	Conc.	0	50	Conc.	0	100	Conc.	0	50	Conc.	0
0.89 - 0.96	T	Conc.	-		-		T	Conc.	-	T	Conc.	-	100	Conc.	0	T	Conc.	-
0.96 - 1.10	75	Grass	3:1		-		75	Grss	3:1	75	Grass	3:1	T	Conc.	-	75	Grass	3:1
1.10 - 1.68	75	Grass	3:1		-		75	Grass	3:1	75	Grass	3:1	150	Grass	3:1	75	Grass	3:1
1.68 - 1.74	T	Riprap	-		-		T	Riprap	-	T	Riprap	-	*T*	*Riprap*	-	*T*	*Riprap*	-
1.74 - 2.00	35	Grass	3:1		-		35	Grass	3:1	35	Grass	3:1	50	Grass	3:1	35	Grass	3:1
2. BRIDGE IMPROVEMENTS																		
A. Cape La Croix Creek														Replace				
Bloomfield Road														Replace				
Hwy 61 (Kingshighway)														Replace				
Independence Street														Replace				
East Rodney Street														Replace				
B. Walker Branch																		
Good Hope Street		Replace						Replace			Replace			Replace			Replace	
William Street		Replace						Replace			Replace			Replace			Replace	
Town Plaza Driverway		Replace						Replace			Replace			Replace			Replace	
Independence Street		Replace						Replace			Replace			Replace			Replace	
Missouri Pacific Railroad		Replace						Replace			Replace			Replace			Replace	
Themis Street		Replace						Replace			Replace			Replace			Replace	
Private Drive		Replace						Replace			Replace			Replace			Replace	
Bessie Street		Replace						Replace			Replace			Replace			Replace	
Broadway Street		Replace						Replace			Replace			Replace			Replace	
Kingsway Street		Replace						Replace			Replace			Replace			Replace	
Marietta Street		Replace						Replace			Replace			Replace			Replace	
3. DRY DETENTION RESERVOIRS																		
Site 1		Yes			No			Yes			Yes			Yes			Yes	
Site 2		No			No			No			No			Yes			No	
4. NON-STRUCTURAL FEATURES																		
Sprigg St. Relocation		No			Yes			Yes			Yes			No			Yes	
Golliday Subdivision Relocation		No			Yes			Yes			Yes			No			Yes	

Legend: T = Transition

RECOMMENDED NON-STRUCTURAL MEASURES

55. The recommended non-structural measures include the relocation of residents and razing of the low-lying structures near Sprigg Street along Cape La Croix Creek and of 31 residences near Terry Lane on Walker Branch to be replaced with a park. Also, in order to obtain sufficient right of way for channel improvements, 8 mobile homes on Walker Branch upstream of Bessie Street would be relocated and replaced by a small strip park. Recreational features such as parks, trails, and picnic sites, were included in the plan and are described in detail in Appendix F.

RECOMMENDED PLAN HYDROLOGIC IMPACTS

56. The Recommended plan provides a high degree of protection from flooding utilizing both structural and non structural measures, provides for recreation, and is economically feasible.

FLOOD PROFILES AND FLOWS.

57. PLATES D-56 through D-61 show the effect of the recommended plan on runoff hydrographs for the floods with a 50, 10, 1 and .2 percent chance of occurrence at several locations. Since the flood control features for the NED plan are the same as those for the Recommended Plan, the hydrographs are applicable for the NED plan. It can be seen that peak flows on Cape La Croix Creek at Hopper Road are reduced considerably due to the storage effect of the dry detention reservoir. On Walker Branch at Bessie Street, flows with the recommended channel improvements are slightly higher than with no improvement. At the mouth of Walker Branch, the less frequent flows with the recommended plan are considerably greater than those with no project. However, these hydrograph plots do not account for the diversion of flow from Cape La Croix Creek to Walker Branch at Independence Street. Because of the reduced flows and greater channel capacities on Cape La Croix Creek, much less flow is diverted with the recommended plan. The net effect at the mouth of Walker Branch is that flows are slightly reduced with the recommended plan. The discharge frequency curves on PLATES D-62 through D-67 show the effect of the recommended plan on peak flow values which take into account the diversion of 40% of the left overbank flow on Cape La Croix Creek to Walker Branch at Independence Street. At the mouth of Cape La Croix Creek, the less frequent flows are somewhat reduced with the recommended plan, but the effect becomes less for the more frequent flows. The effect of the recommended plan or NED plan on water surface elevations is shown in the profiles on PLATES D-68 through D-70, and on the stage frequency curves on PLATES D-71 through D-76. Areas flooded by the floods with a 10, 1, and .2 percent chance of occurrence and the SPF with the recommended plan are shown on PLATES D-77 through D-87. Sensitivity tests were conducted on Mannings roughness coefficients used in the recommended plan model. Profiles were computed assuming 80% and 120% of the roughness coefficient values used. The resulting profiles were then used to compute flood damages. It was found that a reduction of 20% in roughness coefficient resulted in a raise in the water surface profile by less than a foot. The consequence of given

discharges flooding to greater than expected depths would result in a somewhat lower degree of protection for residents and businesses in the flood plain. However, since there are no levees or floodwalls included in the recommended plan, no potential catastrophy would occur due to the project design being exceeded. Also, since the Cape La Croix-Walker basin is well defined, flow over drainage divides will not occur even if water surface profiles are estimated much too low. Sensitivity tests were not performed for expansion and contraction coefficients used in this study. However, such tests were conducted for the Maline Creek urban study recently completed by the St. Louis District. Those tests showed that variations in the coefficients had little effect on average annual damages. Since similar values were used in this study, the same result could logically be expected for the Cape La Croix Creek basin. One factor which was not considered is debris accumulation, which is difficult to predict. However, since in the recommended plan, eight small bridges or culverts on Walker Branch and one on Cape La Croix Creek were assumed replaced with clear spans, the likelihood of debris accumulation at bridges would be reduced with the project.

PAST FLOODS

58. One of the more frequent questions asked by local residents was "How will this recommended plan effect a flood like those we have experienced in the past?" Therefore, the discharges for the May 1973 and March 1977 floods were computed using the recorded rainfalls, assuming the recommended plan in place. These discharges were input in the HEC-2 model for the recommended plan and water surface profiles were computed for each of the floods. The resulting profiles are compared to the historical flood profiles on Plate 17 and 18. The profiles show that water surface elevations would be lowered considerably through the commercial and residential reaches of both Cape La Croix Creek and Walker Branch with the recommended plan in place.

SEDIMENT AND SCOUR

59. Upper reaches of Cape La Croix Creek and Walker Branch appear to be fairly stable at the present time, without much evidence of significant erosion or deposition. The headwaters of Cape La Croix Creek are located in the steep hills north of Cape Girardeau. These hills are mostly wooded or open pasture land with only scattered residential or agricultural development. The channel between Highway 61 at mile 6.1 and the northern city limits of mile 8.45 has a gravelly bottom with some rock outcrops, and shows very little erosion although the channel slope is very steep, about 18 feet per mile. Channel velocities in this upper reach vary between 3 and 9 feet per second for furture conditions without a project. Since no channel improvements are recommended for this reach, no significant change in velocity is anticiapted as a result of the recommended plan. The channel slope between the north Highway 61 crossing and Bloomfield flood is about 8 feet per mile. This reach includes most of the recommended channel improvements on Cape La Croix Creek. Channel velocities in this reach vary between 2.5 and 7 feet per second for future conditions without a project but may exceed these values at bridges. Channel velocities with the recommended

plan vary from 2 to 8 feet per second in the riprap lined reach and from 3 to 9 feet per second in the concrete lined reach of improved channels. Below Bloomfield Road, Cape La Croix Creek has a somewhat flatter slope of 5.5 feet per mile. The channel was straightened and enlarged between miles 2.4 and 2.9 in the early 1970's, cutting off a large meander. Then in the late 1970's, the lower three miles of the channel were cleared of debris and vegetation. Since there are no channel improvements recommended below mile 2.72, some continued channel maintenance may be necessary in the downstream reach. Channel velocities in this reach with the recommended plan vary between 2 and 6 feet per second.

60. No serious erosion problems are evident in the Walker Branch basin. Some deposition of sediment has been observed at the Lombardo and Broadway Street crossings, but appear to be local problems and not widespread. Sediments may have been a result of construction activity in the upper part of the basin which is undergoing residential development. Because the recommended grass lined channel has a wider cross section, some deposition of materials may be expected between miles .89 and 2.00. channel velocities in this reach can be expected to be between 2 and 6 feet per second with the recommended plan. In the concrete lined improved channel, velocities vary from 3 to 8 feet per second.

61. In an attempt to assess the sensitivity of the water surface profiles due to possible deposition in the channel, the hydraulic model for the recommended plan was modified to simulate an accumulation of 2 feet in the channel between Hopper Road at mile 5.11 and East Rodney Street at mile 4.09 and from the downstream end of the concrete channel at mile 2.76 to Wilson Road at mile 1.85. It was found that the profiles for the rare events were raised only slightly, less than 1 foot but for the more frequent, in-bank events, profiles were raised up to 2 feet in both reaches. With proper maintenance, erosion or deposition should not prove to be a significant problem. However, the erosion and sedimentation characteristics of the selected plan should be thoroughly ana'yzed in the post-authorization design memoranda.

CAPE GIRARDEAU-JACKSON

METROPOLITAN AREA, MISSOURI

SURVEY REPORT

APPENDIX E

DESIGN AND COST ESTIMATES

AD-A141 579 WATER RESOURCES INVESTIGATION CAPE GIRARDEAU - JACKSON METROPOLITAN AREA MISSOURI VOLUME 2 APPENDICES(U) ARMY ENGINEER DISTRICT ST LOUIS MO DEC 83 3/4

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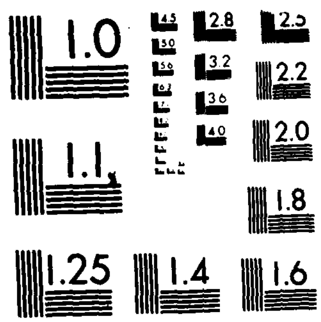

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

CAPE GIRARDEAU - JACKSON
APPENDIX E
DESIGN AND COST ESTIMATES

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CAPE GIRARDEAU - JACKSON
APPENDIX E
DESIGN AND COST ESTIMATES

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CAPE GIRARDEAU - JACKSON

APPENDIX E

DESIGN AND COST ESTIMATES

1. The purpose of this appendix is to present a summary of the detailed design and cost estimates studies accomplished for the Cape Girardeau-Jackson study. This appendix covers only the Cape La Croix Creek and Walker Branch basins. The design and cost estimates herein are based on October 1983 price levels. They are a continuation of the designs and cost estimates developed for Stage II study purposes.

2. The designs for the various structural and non-structural components were based on the best available data, field investigations, and current design procedure. In some instances, the use of engineering judgment was necessary due to the absence of readily available data not normally developed for a report in this stage of design.

3. The real estate requirements for the various designs and components were determined and coordinated with the St. Louis District, Corps of Engineers, Real Estate Division.

4. During plan formulation, numerous plans were considered and developed. From these plans six (6) plans are being carried forward in this report. These plans are:

a. Standard Project Flood Plan (SPF)

b. National Economic Development Plan (NED)

c. Environmental Quality Plan (EQ)

d. Non-Structural Plan

e. Recommended Plan

f. Plan A.

5. The summarized construction costs for each of the plans identified above are shown in TABLE E-1 consistent with the traditional cost sharing policy.

PUBLIC SAFETY CONSIDERATIONS

6. The design of the project components comply with all applicable Corps of Engineers guidance, codes, and regulations. If a component of the

recommended plan failed, there would be only a negligible chance of injury or loss of life to citizens in the basin.

CONSTRUCTION COSTS

7. The detailed design and cost estimates for the recommended plan of improvements are shown in TABLES E-6 and E-7.

TABLE E-1
CAPE GIRARDEAU - JACKSON SURVEY REPORT
PLAN COST COMPARISON - FIRST COSTS
OCTOBER 1983 PRICE LEVEL

	Recommended	National Economic Development	Plan A
A. Federal Costs			
01 Lands & Damages	$ 991,000	$ 0	$ 1,474,000
02 Relocations	310,000	0	310,000
04 Dams	2,900,000	2,900,000	2,900,000
06 Fish & Wildlife	0	0	130,000
09 Channel & Canals	12,800,000	12,800,000	18,600,000
11 Levees & Floodwalls	320,000	320,000	320,000
14 Recreation	180,000	160,000	350,000
30 Engineering & Design	1,959,000	1,920,000	2,721,000
31 Supervision & Administration	1,240,000	1,200,000	1,695,000
TOTAL FEDERAL COSTS	$20,700,000	$19,300,000	$28,500,000

TABLE E-1 (Cont'd)
CAPE GIRARDEAU - JACKSON SURVEY REPORT
PLAN COST COMPARISON - FIRST COSTS
OCTOBER 1983 PRICE LEVEL

	Recommended	National Economic Development	Plan A
B. Non-Federal Costs			
01 Lands and Damages	$ 2,880,000	$ 2,581,000	$ 2,733,000
02 Relocations	1,660,000	1,580,000	1,960,000
06 Fish and Wildlife	0	0	50,000
14 Recreation	260,000	240,000	350,000
30 Engineering & Design	250,000	249,000	310,000
31 Supervision & Administration	150,000	150,000	197,000
TOTAL NON-FEDERAL COSTS	$ 5,200,000	$4,800,000	$5,600,000
TOTAL PROJECT COSTS	$25,900,000	$24,100,000	$34,100,000

TABLE E-1 (Cont'd)
CAPE GIRARDEAU - JACKSON SURVEY REPORT
PLAN COST COMPARISON - FIRST COSTS
OCTOBER 1983 PRICE LEVEL

	Environmental Quality	Standard Project Flood (1)	Non-Structural (1)
A. Federal Costs			
01 Lands & Damages	$ 2,930,000	$1,316,000	$39,600,000
02 Relocations	310,000	310,000	4,300,000
04 Dams	2,900,000	9,840,000	0
06 Fish & Wildlife	170,000	0	0
09 Channel & Canals	18,600,000	27,200,000	0
11 Levees & Floodwalls	320,000	900,000	0
14 Recreation	500,000	0	0
30 Engineering & Design	2,760,000	4,764,000	520,000
31 Supervision & Administration	1,710,000	2,770,000	280,000
TOTAL FEDERAL COSTS	$30,200,000	$47,100,000	$44,700,000

(1) No Recreation or Fish and Wildlife costs were calculated for the SPF and NS Plans because flood control was unjustified.

TABLE E-1 (Cont'd)
CAPE GIRARDEAU - JACKSON SURVEY REPORT
PLAN COST COMPARISON - FIRST COSTS
OCTOBER 1983 PRICE LEVEL

	Environmental Quality	Standard Project Flood (1)	Non-Structural (1)
B. Non-Federal Costs			
01 Lands and Damages	$ 5,064,000	$ 5,454,000	$ 9,956,000
02 Relocations	1,960,000	6,140,000	2,150,000
06 Fish and Wildlife	60,000	0	0
14 Recreation	500,000	0	0
30 Engineering & Design	316,000	736,000	300,000
31 Supervision & Administration	200,000	470,000	194,000
TOTAL NON-FEDERAL COSTS	$ 8,100,000	$12,800,000	$12,600,000
TOTAL PROJECT COSTS	$38,300,000	$59,900,000	$57,300,000

(1) No Recreation or Fish and Wildlife costs were calculated for the SPF and NS Plans because flood control was unjustified.

TABLE E-1 (Cont'd)
CAPE GIRARDEAU - JACKSON SURVEY REPORT
PLAN COST COMPARISON - FIRST COSTS
OCTOBER 1983 PRICE LEVEL

	Recommended	National Economic Development	Plan A
C. Federal Plus Non-Federal Costs.			
01 Lands & Damages	$ 3,871,000	$ 2,581,000	$ 4,207,000
02 Relocations	1,970,000	1,580,000	2,270,000
04 Dams	2,900,000	2,900,000	2,900,000
06 Fish and Wildlife	0	0	180,000
09 Channels & Canals	12,800,000	12,800,000	18,600,000
11 Levees & Floodwalls	320,000	320,000	320,000
14 Recreation	440,000	400,000	700,000
30 Engineering & Design	2,209,000	2,169,000	3,031,000
31 Supervision & Administration	1,390,000	1,350,000	1,892,000
TOTAL PROJECT COSTS	$25,900,000	$24,100,000	$34,100,000

TABLE E-1 (Cont'd)
CAPE GIRARDEAU - JACKSON SURVEY REPORT
PLAN COST COMPARISON - FIRST COSTS
OCTOBER 1983 PRICE LEVEL

	Environmental Quality	Standard Project Flood (1)	Non-Structural (1)
C. Federal Plus Non-Federal Costs.			
01 Lands & Damages	$ 7,994,000	$ 6,770,000	$49,556,000
02 Relocations	2,270,000	6,450,000	6,450,000
04 Dams	2,900,000	9,840,000	0
06 Fish and Wildlife	230,000	0	0
09 Channels & Canals	18,600,000	27,200,000	0
11 Levees & Floodwalls	320,000	900,000	0
14 Recreation	1,000,000	0	0
30 Engineering & Design	3,076,000	5,500,000	820,000
31 Supervision & Administration	1,910,000	3,240,000	474,000
TOTAL PROJECT COSTS	$38,300,000	$59,900,000	$57,300,000

(1) No Recreation or Fish and Wildlife costs were calculated for the SPF and NS Plans because flood control was unjustified.

RIGHTS-OF-WAY

8. Approximate permanent rights-of-way required for the recommended plan of improvements are as follows:

a. Land for Stream Corridor -	32.42	acres
(1) Flood Control -	28.19	acres
(2) Recreation (Connecting Trail)	4.23	acres
b. Land for Detention Reservoir -	(157.27)	acres
(1) Flood Control (Fee Acquisition) -	17.3	acres
(a) Damsite and Spillway (10.8 Ac)		
(b) Construction Access (5.5 Ac)		
(c) Channel Realignment (1.0 Ac)		
(2) Flood Control (Flowage Easement)-	72.07	acres
(3) Recreation (Fee Acquisition)	67.9	acres
(a) Area Within Flowage Easement Boundary (43.5 Ac)		
(b) Area Outside Flowage Easement Boundary (24.4 Ac)		
1 Access, Parking, Potable Water and Sanitation ((5.6 Ac))		
2 Squaring, Rounding and Uneconomical Remnants ((18.8 Ac))		
c. Land for Sprigg Street -	9	acres
d. Land for Golliday Addition -	7	acres
TOTAL LANDS REQUIRED -	205.69	acres

OPERATION AND MAINTENANCE

9. Maintenance would include adequate measures to insure that the project objectives are maintained for the duration of the project life. Project components and their annual maintenance costs are shown in TABLE E-2. The annual maintenance costs include, but are not limited to, the following items of work: grass mowing, trash and debris removal, crushed stone repair, embankment inspection and repair, seeding and sodding, riprap repair, concrete repair, water supply, sewer fee, trash pickup, miscellaneous supplies, building and structure repair and maintenance, trail repair, and pavement repair. The project would be transferred to the local sponsor for operation and maintenance immediately after completion. Subsequent to completion, an operation and maintenance manual would be prepared by the St. Louis District and furnished to the local sponsor.

MAJOR REPLACEMENTS

10. Major replacements of significant project features may be required to insure that project objectives are functional for the duration of the 100-year estimated project life. These major replacement requirements are assumed to occur at varying time intervals. The average annual equivalent costs of the major replacements are shown in TABLE E-3 based on 8-1/8 percent interest and October 1983 price levels. These costs are

TABLE E-2
CAPE GIRARDEAU-JACKSON
ANNUAL OPERATION AND MAINTENANCE COSTS
OCTOBER 1983 PRICE LEVELS

Item	Recommended	NED	Plan A
Detention Reservoir	$15,300	$15,300	$15,300
Channel Improvements	20,100	20,100	44,000
Bridges	8,700	8,700	8,700
Recreation	14,000	13,000	11,000
TOTAL O&M COSTS	$58,100	$57,100	$79,000

Item	EQ	SPF	Non-Structural
Detention Reservoir	$15,300	$ 43,000	$ 0
Channel Improvements	44,000	85,000	0
Bridges	8,700	31,000	8,000
Recreation	14,000	0	0
TOTAL O&M COSTS	$82,000	$159,000	$ 8,000

FOOTNOTE: - These annual estimated costs are entirely a non-Federal responsibility subsequent to project construction.

TABLE E-3
CAPE GIRARDEAU-JACKSON
ANNUAL EQUIVALENT MAJOR REPLACEMENT COSTS (1)
OCTOBER 1983 PRICE LEVELS

Item	Recommended	NED	Plan A
Channels (25-year intervals)	$ 43,500	$ 43,500	$ 63,200
Bridges and Detention Reservoir (50-year intervals)	2,200	2,200	2,500
TOTAL ANNUAL MAJOR REPLACEMENTS COSTS	$ 45,700	$ 45,700	$ 65,700

Item	EQ	SPF	Non-Structural
Channels (25-year intervals)	$ 63,200	$ 92,400	$ 0
Bridges and Detention Reservoir (50-year intervals)	2,500	7,400	0
TOTAL ANNUAL MAJOR REPLACEMENTS COSTS	$ 65,700	$ 99,800	$ 0

FOOTNOTE (1): - These annual equivalent estimated costs are entirely a non-Federal responsibility subsequent to project construction.

in addition to the normal operation and maintenance costs previously discussed. The local sponsor is required to accomplish all major replacements as they become necessary to insure that the project will meet its objectives for the projected life of the project.

TOTAL AVERAGE ANNUAL COSTS

11. The total average annual costs based on 8-1/8 percent interest and October 1983 price levels for the final array of six alternative potential plans of improvements are shown in TABLE E-4.

TABLE E-4
CAPE GIRARDEAU-JACKSON
TOTAL AVERAGE ANNUAL COSTS
BASED ON 8-1/8 PERCENT INTEREST AND OCTOBER 1983 PRICE LEVELS

	Recommended	NED	Plan A
First Costs	$2,105,200	$1,958,900	$2,771,700
O&M	58,100	57,100	79,000
Replacements	45,700	45,700	65,700
TOTAL ANNUAL COSTS	$2,209,000	$2,061,700	$2,916,400

TABLE E-4 (Cont'd)
CAPE GIRARDEAU-JACKSON
TOTAL AVERAGE ANNUAL COSTS
BASED ON 8-1/8 PERCENT INTEREST AND OCTOBER 1983 PRICE LEVELS

	EQ	SPF	Non-Structural
First Costs	$3,113,100	$4,868,800	$4,657,500
O&M	82,000	159,000	$ 8,000
Replacements	65,700	99,800	0
TOTAL ANNUAL COSTS	$3,260,800	$5,127,600	$4,665,500

FEDERAL AND NON-FEDERAL CONSTRUCTION COSTS

12. A summary of the Federal and non-Federal construction cost sharing required for the recommended plan of improvements for each project purpose based on October 1983 price levels are shown in TABLE E-5.

TABLE E-5
CAPE GIRARDEAU-JACKSON
FEDERAL AND NON-FEDERAL CONSTRUCTION COSTS
BASED ON OCTOBER 1983 PRICE LEVELS
RECOMMENDED PLAN

ITEM	LANDS	RELOCATIONS	IMPROVEMENTS	TOTALS
1. FEDERAL COSTS				
a. Flood control	$ 980,000	$ 370,000	$19,119,000	$20,469,000
b. Recreation	11,000	0	220,000	231,000
c. Subtotal	$ 991,000	$ 370,000	$19,339,000	$20,700,000
2. NON-FEDERAL COSTS				
a. Flood control	$2,691,000	$2,006,000	$ 0	$ 4,697,000
b. Recreation	189,000	0	314,000	503,000
c. Subtotal	$2,880,000	$2,006,000	$ 314,000	$ 5,200,000
3. Summary of First Costs, Federal Plus Non-Federal, by Project Purpose				
a. Flood Control	$3,671,000	$2,376,000	$19,119,000	$25,166,000
b. Recreation	200,000	0	534,000	734,000
d. Total Costs	$3,871,000	$2,376,000	$19,653,000	$25,900,000

DETAILED COST ESTIMATE

CONSTRUCTION COSTS - FEDERAL

13. The specific line item estimate Federal construction costs for the recommended plan based on traditional cost apportionment and October 1983 price levels are shown in TABLE E-6.

TABLE E-6
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
01	LANDS AND DAMAGES				($991,000)
	Separable Land at Detention Reservoir For Recreation (1/2 Federal, 1/2 Non-Federal)				
	Land (Fee Acquisition)(Access Sanitation & Potable Water)	4.6	Ac.	$1,000.00	$ 4,600
	Comfort Station	1.0	Ac.	1,000.00	1,000
	Subtotal				$ 5,600
	Improvements	Sum	Job		0
	Damages				560
	Subtotal (Round)				$ 6,000
	Contingencies				1,000
	Acquisition Costs				14,000
	Relocation Assistance				1,000
	Total Land at Detention Reservoir for Recreation				$ 22,000
	Federal				$ 11,000
	Non-Federal				$ 11,000
	Lands for Nonstructural Relocations (80% Federal - 20% Non-Federal)				
	Land at Golliday Addition				
	Residential Land	Sum	Job		$ 54,500
	Improvements	Sum	Job		206,000
	Subtotal				$260,500
	(Round)				261,000

TABLE E-6 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
01	LANDS AND DAMAGES (cont'd)				
	Contingencies				65,000
	Acquisition Costs				36,000
	PL 91-646				90,000
	Total Lands for Non-Structural Relocations at Golliday Addition				$452,000
	Land at Sprigg Street				
	Residential Land and Improvements	Sum	Job		$143,100
	Commercial Land and Improvements	Sum	Job		136,200
	Damages				27,930
	Contingencies				76,807
	Relocation Assistance				298,000
	Acquisition Costs				90,000
	Total Lands for Non-Structural Relocation at Sprigg Street				$772,037
	Round to Agree with Appraisal				$772,000
	TOTAL FOR NON-STRUCTURAL RELOCATIONS				$1,224,000

TABLE E-6 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
	FEDERAL COSTS (80%)				$ 980,000
	NON-FEDERAL COSTS (20%)				$ 244,000
	TOTAL LANDS AND DAMAGES				$ 991,000
02	RELOCATIONS				($310,000)
	Nonstructural Relocations (80% Federal - 20% Non-Federal)				
	Golliday Addition Structure Removal				
	Demolish, Remove, and Restore Land Surface at Structures	18	EA	$5,700	$102,600
	Subtotal				$102,600
	Contingencies				27,400
	Subtotal For Golliday Addition				$130,000
	Sprigg Street Structure Removal				
	Demolish, Remove, and Restore Land Surface at Structures	37	EA	$5,700	$210,900
	Subtotal				210,900
	Contingencies				$ 49,100
	Subtotal for Sprigg Street				$260,000
	Total Non-structural Relocations				$390,000
	Federal (80%)				$310,000
	Non-Federal (20%)				$80,000

TABLE E-6 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
04	DAMS				($2,900,000)
	Detention Reservoir - Site 1				
	Dam				
	Diversion and Care of Flow	Sum	Job		$ 34,000
	Clearing and Grubbing	5	Acre	$1,400.00	7,000
	Stripping	8,000	C.Y.	1.70	13,600
	Embankment	147,000	C.Y.	4.80	705,600
	Excavation				
	(Inspection Trench)	3,000	C.Y.	2.75	8,250
	Riprap	6,000	Ton	22.50	135,000
	Bedding Material	3,000	Ton	18.00	54,000
	Sand Drain	21,000	Ton	14.00	294,000
	Seeding	3	Acre	1,250.00	3,750
	Crushed Stone Surfacing	400	Ton	11.00	4,400
	Access Roads	3,300	S.Y.	11.00	36,300

TABLE E-6 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
04	DAMS (cont'd)				
	Spillway				
	Dewatering	Sum	Job		34,000
	Clearing	3	Acre	1,400.00	4,200
	Excavation; Common	5,000	C.Y.	4.00	20,000
	Excavation; Rock	15,000	C.Y.	14.00	210,000
	Riprap	1,600	Ton	22.50	36,000
	Bedding Material	800	Ton	20.00	16,000
	Concrete	2,300	C.Y.	230.00	529,000
	Outlet Works				
	Structure	Sum	Job		$115,000
	Pipe, 54-in. Diamater	340	L.F.	$100.00	34,000
	Riprap	300	Ton	22.50	6,750
	Bedding Material	150	Ton	18.00	2,700

TABLE E-6 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
04	DAMS (cont'd)				
	Outlet Works (cont'd)				
	Subtotal				$2,303,550
	Contingencies				596,450
	Total for Detention Site 1				$2,900,000
	TOTAL FOR DAMS				$2,900,000
09	CHANNELS AND CANALS				($12,800,000)
	Channels				
	Care of Flow	Sum	Job		$ 80,000
	Clearing	9.0	Ac.	$ 600.00	5,400
	Excavation	210,000	C.Y.	4.00	840,000
	Backfill	17,800	C.Y.	1.70	30,260
	Seeding	5.0	Ac.	900.00	4,500
	Filter Material	58,500	Ton	17.00	994,500
	Concrete	27,200	C.Y.	280.00	7,616,000

TABLE E-6 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
09	CHANNELS AND CANALS (cont'd)				
	Channels (cont'd)				
	Riprap	19,300	Ton	22.50	434,250
	Bedding Material	9,700	Ton	17.00	164,900
	Litter & Debris Removal	Sum	Job		11,000
	Subtotal				$10,180,810
	Contingencies				2,619,190
	TOTAL FOR CHANNELS				$12,800,000
11	LEVEES AND FLOODWALLS				($320,000)
	Levee Around Sewage Lagoon at Detention Reservoir				
	Embankment	36,000	C.Y.	3.00	$ 108,000
	Riprap	5,000	Ton	20.00	100,000
	Bedding Material	2,500	Ton	15.00	37,500
	Clearing	1	Ac.	1,200.00	1,200
	Seeding	6	Ac.	1,100.00	6,600

TABLE E-6 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
11	LEVEES AND FLOODWALLS (cont'd)				
	Levee Around Sewage Lagoon at Detention Reservoir (cont'd)				
	Subtotal				$253,300
	Contingencies				66,700
	Subtotal				$320,000
	TOTAL FOR LEVEES AND FLOODWALLS				$320,000
14	RECREATION				($180,000)
	($360,000 which is shared 1/2 Federal, 1/2 Non-Federal)				
	Stream Corridor				
	Hike and Bike Trail	2.81	Mile	$18,500.00	51,985
	Subtotal				$ 51,985
	Contingencies				8,015
	TOTAL STREAM CORRIDOR				$ 60,000

TABLE E-6 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - FEDERAL
-TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
14	RECREATION (cont'd)				
	Sprigg Street Site				
	Picnic Tables	5	Ea.	$ 800.00	$ 4,000
	Parking Area (6 cars)	2,250	S.F.	.75	1,688
	Drinking Fountain	1	Ea.	1,800.00	1,800
	Water Lines	200	L.F.	8.00	1,600
	Fishing Pier	1	Ea.	2,500.00	2,500
	Open Play Areas	2	Ac.	3,000.00	6,000
	Subtotal				$17,588
	Contingencies				6,412
	TOTAL SPRIGG STREET SITE				$24,000
	Bessie Street Site				
	Picnic Table	3	Ea.	$ 800.00	$2,400
	Drinking Fountain	1	Ea.	1,800.00	1,800

TABLE E-6 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
14	RECREATION (cont'd)				
	Subtotal				$4,200
	Contingencies				1,800
	TOTAL BESSIE STREET SITE				$6,000
	Golliday Addition Site				
	Picnic Tables	10	Ea.	$800.00	8,000
	Water Lines	100	L.F.	8.00	800
	Exercise Trail	1	Mile	12,000.00	12,000
	Subtotal				$20,800
	Contingencies				9,200
	TOTAL FOR GOLLIDAY ADDITION SITE				$30,000
	Detention Site 1				
	Parking Lot				
	(3 ea. 10, 10 & 25 car)	16,900	S.F.	$ .75	12,675
	Open Play Area	4	Ac.	3,000.00	12,000

TABLE E-6 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
14	RECREATION (cont'd)				
	Water Lines	3,000	L.F.	$ 8.00	$ 24,000
	Comfort Stations (Large)	2	Ea.	20,000.00	40,000
	Comfort Stations (Small)	1	Ea.	17,000.00	17,000
	Nature Trails	0.5	Mile	21,000.00	10,500
	Group Camp (30 people)	1	Ea.	7,000.00	7,000
	Exercise Trail	1	Mile	12,000.00	12,000
	Disc Course	1	Ea.	15,000.00	15,000
	Picnic Tables	25	Ea.	800.00	20,000
	Hiking and Biking Trail	1.1	Mile	18,500.00	20,350
	Subtotal				$190,525
	Contingencies				49,475
	TOTAL FOR DETENTION SITE 1				$240,000
	TOTAL FOR RECREATION				$360,000
	1/2 Federal Cost				$180,000
	1/2 Non-Federal Cost				$180,000

TABLE E-6 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
30	ENGINEERING AND DESIGN				$1,959,000
31	SUPERVISION AND ADMINISTRATION				$1,240,000
	TOTAL FEDERAL COSTS				$20,700,000

CONSTRUCTION COSTS - NON-FEDERAL

14. The specific line item estimated non-Federal construction costs for the recommended plan based on traditional cost apportionment and October 1983 price levels are shown in TABLE E-7.

TABLE E-7
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - NON-FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
01	LANDS AND DAMAGES				($2,880,000)
	Land for Stream Corridor				
	Flood Protection	9.096	Ac.	$ 600.00	$ 5,458
		3.183	Ac.	750.00	2,387
		1.92	Ac.	1,600.00	3,072
		7.349	Ac.	2,000.00	14,698
		289,238.40	S.F.	3.50	1,012,334
	Subtotal				$1,037,949
	Land for 10 Residences				
	at Golliday Addition	Sum	Job		$ 36,000
	Subtotal				$36,000

TABLE E-7 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - NON-FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
01	LANDS AND DAMAGES (cont'd)				
	Land for Stream Corridor				
	Recreation				
		4,000	S.F.	$ 1.00	$ 4,000
		16,000	S.F.	1.00	16,000
		30,000	S.F.	1.50	45,000
		23,000	S.F.	0.40	9,200
		2.546	Ac.	1,200.00	3,055
	Subtotal				$77,255
	TOTAL STREAM CORRIDOR LANDS				$1,151,204
	Land at Detention Reservoir For Flood Protection				
	(Fee Acquisition)				
	Dam and Spillway	10.8	Ac.	$1,200.00	$ 12,960
	Bottomland	35.0	Ac.	1,200.00	42,000
	Woodland	15.0	Ac.	700.00	10,500

TABLE E-7 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - NON-FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
01	LANDS AND DAMAGES (cont'd)				
	Subtotal for Fee Acquisition				$65,460
	(Easement Acquisition)				
	Bottomland	46.5	Ac.	$1,200.00	$ 55,800
	Upland	20.39	Ac.	1,000.00	20,390
	Woodland	5.18	Ac.	700.00	3,626
	Subtotal for Easement Acquisition				$79,816
	Subtotal Land and Detention Reservoir For Flood Protection				$145,276
	Improvements				
	Commercial Building	Sum	Job		$75,000
	Nursery Display	Sum	Job		1,500
	Gravel Parking Area	Sum	Job		3,300
	Asphalt Drive to Service and Shopping Center Entrance	Sum	Job		7,500

TABLE E-7 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - NON-FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
01	LANDS AND DAMAGES (cont'd)				
	Commercial Building	Sum	Job		71,500
	Utility Buildings	3	Ea.	$ 150.00	450
	Golliday Addition				
	Residences	10	Ea.	13,300.00	133,000
	Subtotal Improvements				$292,250
	Damages	Sum	Job		$141,752
	Subtotal Damages				$141,752
	Contingencies	Sum	Job		$431,866
	Subtotal Contingencies				$431,866
	Relocation	Sum	Job		$106,150
	Subtotal Relocation				$106,150

TABLE E-7 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - NON-FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
01	LANDS AND DAMAGES (cont'd)				
	Acquisition Costs	Sum	Job		$311,000
	Subtotal Acquisition				$311,000
	SUBTOTAL LANDS AND DAMAGES				$2,579,283
	ROUND TO AGREE WITH APPRAISAL DATED 13 Oct 83				$2,581,000
	LANDS FOR NONSTRUCTURAL RELOCATIONS (See Federal Lands and Damages)				$244,000
	LANDS AT DETENTION RESERVOIR FOR RECREATION (1/2 Federal, 1/2 Non-Federal) (See Federal Lands and Damages)				$11,000
	SEPARABLE LANDS AT DETENTION RESERVOIR FOR RECREATION (100% Non-Federal)				

TABLE E-7 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - NON-FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
01	LANDS AND DAMAGES (cont'd)				
	LAND (Fee Acquisition)				
	Bottomland	18.1	acres	$1,200.00	$21,720
	Upland	0.7	acres	1,000.00	700
	Subtotal				$22,420
	Improvements	Sum	Job		2,000
	Damages				2,442
	Subtotal (Round)				$27,000
	Contingencies				7,000
	Acquisition Costs				9,000
	Relocation Assistance				1,000
	Total Land at Detention Reservoir for Recreation (100% Non-Federal)				$44,000
	TOTAL LANDS AND DAMAGES				**$2,880,000**

TABLE E-7 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - NON-FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
02	RELOCATIONS				($1,660,000)
	Good Hope Street Bridge Replacement				
	Remove Existing Bridge	Sum	Job		$17,000
	New Bridge	1,440	S.F.	$50.00	72,000
	Subtotal				$ 89,000
	Contingencies				21,000
	Subtotal for Good Hope Street Bridge				$110,000
	William Street Bridge Replacement				
	Remove Existing Bridge	Sum	Job		$ 28,000
	New Bridge	2,640	S.F.	$50.00	132,000
	Subtotal				$160,000
	Contingencies				40,000
	Subtotal for William Street Bridge				$200,000

TABLE E-7 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - NON-FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
02	RELOCATIONS (cont'd)				
	Town Plaza Drive Bridge Replacement				
	Remove Existing Bridge	Sum	Job		$17,000
	New Bridge	1,440	S.F.	$50.00	72,000
	Subtotal				$89,000
	Contingencies				21,000
	Subtotal for Town Plaza Drive Bridge				$110,000
	Independence Street Bridge Replacement				
	Remove Existing Bridge	Sum	Job		$17,000
	New Bridge	1,440	S.F.	$50.00	72,000
	Subtotal				89,000
	Contingencies				21,000
	Subtotal for Independence Street Bridge				$110,000

TABLE E-7 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - NON-FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
02	RELOCATIONS (cont'd)				
	Themis Street Bridge Replacement				
	Remove Existing Bridge	Sum	Job		$14,000
	New Bridge	1,200	S.F.	$50.00	60,000
	Subtotal				$74,000
	Contingencies				26,000
	Subtotal for Themis Street Bridge				$100,000
	Private Drive Bridge Removal				
	Remove Existing Bridge	Sum	Job		20,000
	New Bridge	2,000	S.F.	$50.00	100,000
	Subtotal				$120,000
	Contingencies				30,000
	Subtotal for Private Drive Bridge				$150,000

TABLE E-7 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - NON-FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
02	RELOCATIONS (cont'd)				
	Bessie Street Bridge Replacement				
	Remove Existing Bridge	Sum	Job		$14,000
	New Bridge	1,200	S.F.	$50.00	60,000
	Subtotal				$74,000
	Contingencies				26,000
	Subtotal for Bessie Street Bridge				$100,000
	Marietta Street Bridge Replacement				
	Remove Existing Bridge	Sum	Job		10,000
	New Bridge	1,200	S.F.	$50.00	$60,000
	Subtotal				$70,000
	Contingencies				20,000
	Subtotal for Marietta Street Bridge				$90,000

TABLE E-7 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - NON-FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
02	RELOCATIONS (Cont'd)				
	Golliday Addition Structure Removal				
	For Flood Control				
	Demolish, Remove, and Restore				
	Land Surface at Structures	10	Ea.	$ 5,700.00	$57,000
	Subtotal				$57,000
	Contingencies				
	Subtotal for Golliday				
	Addition Structure				13,000
	Removal for Flood Control				$70,000
	NONSTRUCTURAL RELOCATIONS (80% FEDERAL - 20% NON-FEDERAL)				
	NON-FEDERAL RELOCATIONS				($80,000)

TABLE E-7 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - NON-FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
	UTILITIES				
	Gas Transmission Alterations				
	3 inch dia. Coated Steel Pipe	1,400	L.F.	$17.00	$23,800
	4 inch dia. Coated Steel Pipe	300	L.F	22.50	6,750
	8 inch dia Coated Steel Pipe	200	L.F.	50.00	10,000
	3 inch dia Cast Iron Pipe	800	L.F.	20.50	16,400
	10 inch dia Cast Iron Pipe	200	L.F.	34.00	6,800
	Subtotal Gas Transmission Pipe				$63,750
	Contingencies				16,250
	Total Gas Transmission Alterations				$80,000
	Water Supply System Alterations				
	6 inch dia. Ductile Iron Pipe	600	L.F.	$19.00	$11,400
	8 inch dia. PVC pipe	800	L.F.	28.00	22,400
	8 inch dia. Ductile Iron Pipe	200	L.F.	26.00	5,200
	12 inch dia. Ductile Iron Pipe	200	L.F.	39.00	7,800
	14 inch dia. Ductile Iron Pipe	350	L.F.	43.00	15,050

TABLE E-7 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - NON-FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
	Subtotal Water Supply System Alterations				$61,850
	Contingencies				18,150
	Total Water Supply System Alterations				$80,000
	Telephone System Alterations				
	900 pr Buried Cable	300	L.F.	$16.00	$4,800
	600 pr Buried Cable	2,400	L.F.	11.00	26,400
	200 pr Buried Cable	1,000	L.F.	7.00	7,000
	9 Way Conduit	700	L.F.	39.00	27,300
	16 Way Conduit	500	L.F.	46.50	23,250
	Subtotal Telephone System Alterations				$88,750
	Contingencies				21,250
	Total Telephone System Alterations				$110,000

TABLE E-7 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - NON-FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
	Sewer System Alterations				
	Manhole Removal and Replacement	17	EACH	$1,400.00	23,800
	8 inch dia. PVC Pipe	400	L.F.	9.00	3,600
	10 inch dia. PVC Pipe	800	L.F.	11.00	8,800
	12 inch dia. PVC Pipe	200	L.F.	12.50	2,500
	8 inch dia. Ductile Iron Pipe	700	L.F.	20.50	14,350
	12 inch dia. Ductile Iron Pipe	200	L.F.	30.00	6,000
	15 inch dia. Ductile Iron Pipe	600	L.F.	42.00	25,200
	18 inch dia. Reinforced Concrete Pipe	900	L.F.	19.00	17,100
	30 inch dia. Reinforced Concrete Pipe	700	L.F.	40.00	28,000

TABLE E-7 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - NON-FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
	Sewer System Alternations (Cont'd)				
	Pipe Insulation				
	2 inch X 8 inch	100	L.F.	11.00	1,100
	8 inch dia. Pipe Removal	650	L.F.	2.80	1,820
	10 inch dia. Pipe Removal	800	L.F.	3.10	2,480
	12 inch dia. Pipe Removal	250	L.F.	3.40	850
	15 inch dia. Pipe Removal	300	L.F.	4.00	1,200
	18 inch dia. Pipe Removal	700	L.F.	4.50	3,150
	27 inch dia. Pipe Removal	700	L.F.	5.70	3,990
	Subtotal Sewer System Alterations				$143,940
	Contingencies				46,060
	Total Sewer System Alterations				$190,000
	Electric Power Alterations				
	Remove and Reinstall				
	3 phase Line	11,000	L.F.	5.70	$62,700

TABLE E-7 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - NON-FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
	Electric Power System Alterations (Cont'd)				
	Subtotal Electric Power System Alterations				$62,700
	Contingencies				17,300
	Total Electric Power System Alterations				$80,000
	TOTAL UTILITIES				$540,000
	TOTAL FOR RELOCATIONS				$1,660,000
14	RECREATION				($260,000)
	(1/2 Federal, 1/2 Non-Federal)				$180,000
	(See Federal Recreation)				

TABLE E-7 (cont'd)
CAPE GIRARDEAU-JACKSON
DETAILED COST ESTIMATE FOR THE RECOMMENDED PLAN
CONSTRUCTION COSTS - NON-FEDERAL
TRADITIONAL CONSTRUCTION COST APPORTIONMENT

Cost Acct. No.	Description	Quantity	Unit	Unit Price	Total Estimated Cost
	Stream Corridor (100% Non-Federal)				
	Hike and Bike Trail	3.30	Mile	$18,500.00	$61,050
	Subtotal				$61,050
	Contingencies				18,950
	TOTAL STREAM CORRIDOR (100% Non-Federal)				$ 80,000
	TOTAL FOR RECREATION				$260,000
30	ENGINEERING AND DESIGN				($250,000)
31	SUPERVISION AND ADMINISTRATION				($150,000)
	TOTAL NON-FEDERAL COSTS				$5,200,000
	TOTAL PROJECT COSTS				$25,900,000

TRADITIONAL COST SHARING FOR THE RECOMMENDED PLAN

15. A summary of the Federal and non-Federal construction cost sharing required for the recommended plan of improvements for each project purpose based on October 1983 price levels are shown in TABLE E-8.

RECOMMENDED PLAN COSTS BY PROJECT PURPOSE

16. The project costs by project purpose for the recommended plan of improvements are shown in TABLE E-9.

ANNUAL COSTS OF FINAL ALTERNATIVES BY PROJECT PURPOSE

17. The annual costs of final alternatives by project purpose are shown in TABLE E-10.

TABLE E-8
CAPE GIRARDEAU-JACKSON
FEDERAL AND NON-FEDERAL CONSTRUCTION COSTS
BASED ON OCTOBER 1983 PRICE LEVELS
RECOMMENDED PLAN

ITEM	LANDS	RELOCATIONS	IMPROVEMENTS	ENGINEERING AND DESIGN	SUPERVISION AND ADMINISTRATION	TOTALS
1. FEDERAL COSTS						
a. Flood Control	$ 980,000	$ 310,000	$16,020,000	$1,933,000	$1,226,000	$20,469,000
b. Recreation	11,000	0	180,000	26,000	14,000	231,000
c. Subtotals	991,000	310,000	16,200,000	1,959,000	1,240,000	20,700,000
2. NON-FEDERAL COSTS						
a. Flood Control	$2,691,000	$1,660,000	$ 0	$ 216,000	$ 130,000	$ 4,697,000
b. Recreation	189,000	0	260,000	34,000	20,000	503,000
c. Subtotals	$2,880,000	$1,660,000	$ 260,000	$ 250,000	$ 150,000	$ 5,200,000
3. TOTALS	$3,871,000	$1,970,000	$16,460,000	$2,209,000	$1,390,000	$25,900,000

TABLE E-9
CAPE GIRARDEAU-JACKSON
RECOMMENDED PLAN COSTS BY PROJECT PURPOSE
BASED ON 8-1/8 PERCENT INTEREST AND OCTOBER 1983 PRICE LEVELS

Project Purpose	Construction First Cost	Annual First Cost Equivalent	Annual O&M Cost	Annual Major Replacement	Annual Total Project Cost
Flood Control	$25,166,000	$2,045,600	$44,100	$45,700	$2,135,400
Recreation	734,000	59,600	14,000	0	73,600
PROJECT TOTAL	$25,900,000	$2,105,200	$58,100	$45,700	$2,209,000

TABLE E-10
CAPE LA CROIX CREEK AND WALKER BRANCH
FINAL ALTERNATIVES AND RECOMMENDED PLAN COMPARISON
BASED ON OCTOBER 1983 PRICE LEVELS AND 8-1/8 PERCENT INTEREST

ITEM	RECOMMENDED	NED	EQ	SPF (1)	NS (1)	PLAN 'A'
1. ANNUAL COSTS						
a. Flood Control	$2,135,400	$1,998,800	$2,785,100	$5,127,600	$4,665,500	$2,785,100
b. Fish & Wildlife	0	0	326,800	0	0	39,000
c. Recreation	73,600	62,900	148,900	0	0	92,300
d. TOTAL	$2,209,000	$2.061,700	$3,260,800	$5,127,600	$4,665,500	$2,916,400

(1) No Recreation or Fish and Wildlife costs were calculated for the SPF and NS Plans because flood control was unjustified.

CAPE GIRARDEAU-JACKSON

METROPOLITAN AREA, MISSOURI

SURVEY REPORT

APPENDIX F

ENVIRONMENTAL AND RECREATION RESOURCES

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APPENDIX F
ENVIRONMENTAL AND RECREATION RESOURCES

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APPENDIX F

ENVIRONMENTAL AND RECREATION RESOURCES

1. The purpose of this appendix is to present the detailed environmental and recreation data and their analyses accomplished for the Cape Girardeau-Jackson Study Area. This appendix emphasizes the final array of alternative solutions considered and the Recommended Plan.

2. The information presented in the environmental portion of this appendix summarizes: (1) the existing and future environmental conditions; (2) the environmental problems, needs and opportunities; (3) the environmental objectives and criteria; and (4) the environmental plan formulation and impact assessment process. The recreation section of the appendix discusses the existing and future outdoor recreational conditions, and presents a summary of the recommended recreation features and the plans considered.

EXISTING ENVIRONMENTAL CONDITIONS

LAND RESOURCES

3. Geology. Information on the geology of the Cape Girardeau-Jackson Study area has been placed in the St. Louis District files.

4. Soils. The U. S. Soil Conservation Service (SCS) in cooperation with the Missouri Agricultural Experiment Station recently published a soil survey (1981) for Cape Girardeau County. The predominant soil association in the Cape Hills portion of the study area is the Menfro-Clarksville Association. The Haymond-Wakeland Association is also an important soil type. Specific soil units that would meet the requirements for prime farmland are Menfro silt loam, Wakeland silt loam, and Haymond silt loam. However, in certain areas of the watershed, these soils, due to flood frequency (more than once every 2 years) and topography, would not be classified as prime farmland.

AIR RESOURCES

5. Air Quality. The air quality of the project area is presently attaining federal (Personal Communication with Mr. Langston of the Kansas City office of the U.S. Environmental Protection Agency, (EPA)) and state (Personal Communication with Mr. Raymond of the Missouri Department of Natural Resources) minimum air quality standards. Compliance with Federal and state regulations would be required during construction of any Corps project.

6. Noise. Noise levels in the project area are generally within the recommended limits established by the EPA (Personal Communication with Mr. Tyler of the Kansas City office). Neither the EPA nor the state presently have the authority to enforce noise standards; regulation of noise is primarily via complaints acted upon at the local level.

7. Climate. Data on the climate of the study area are in the St. Louis District's files.

WATER RESOURCES

8. Wastewater Management. Based on the water quality investigation conducted by the Southeast Missouri State University in the spring of 1975, point pollution sources potentially affecting the quality of water in Cape La Croix Creek, include the combined sewer overflow from the Henderson Avenue grit removal and lift station in Cape Girardeau, and sewage lagoons from outlying residential and commercial developments.

9. State and local facilities planning to improve point pollution control is underway. Section 201 of the Water Pollution Control Act provides Federal grants for facilities planning and construction. The Missouri Department of Natural Resources (MDNR) has designated Cape Girardeau as a facilities planning area.

10. Cape Girardeau's facilities plan calls for minor wastewater collection system improvements and major sewage treatment plant improvements.

11. The Cape Girardeau area's non-point pollution problems are considered to be similar to those in many small cities and agricultural areas in the state. Storm runoff from the urban surroundings carries polluting materials into Cape La Croix Creek.

12. Section 208 of Public Law 92-500 requires that areawide point and non-point pollution problems be addressed. EPA and MDNR do not consider Cape Girardeau's areawide and non-point pollution problems serious enough to merit the area's designation as a "208 area."

13. Water Quality. Although improved water quality is obviously related to improved wastewater management facilities, water quality can also be affected by other programs, e.g., stream bank erosion control and dedication of green belts along streams. For this reason, wastewater management and water quality are treated separately in the Cape Girardeau project area.

14. The Missouri Clean Water Commission has classified Cape La Croix Creek as effluent limited, that is water quality does or is expected to meet applicable water quality criteria after the application of a base level of required treatment. This base level of treatment is defined as the best practicable control technology currently available for industrial point sources.

15. Specific data from the Southeast Missouri State University's (1975) water quality investigation is provided below for Cape La Croix Creek. The survey's sampling stations charaterized the existing water quality of the Ozark Uplands (station CLC-11), through the urban areas of Cape Girardeau (station CLC-5), to the Southeastern Lowlands (station CLC-1). These stations also corresponded closely to the locations of three aquatic sampling stations (PLATE F-1) as follows: station CLC-11 corresponded to aquatic station 1; station CLC-5 to station 4; and station CLC-1 to station 3. TABLE F-1 summarizes the water quality for the investigation. Of 20 parameters measured, 15 did not demonstrate any significant differences (0.05 level) among stations. In general, concentrations appeared to increase from upstream to downstream.

16. Based upon the standards established by the Missouri Clean Water Commission, Southeast Missouri State University concluded that the water quality in the Cape La Croix Creek was acceptable for existing uses. Furthermore, they observed that during periods of "sufficient" flow, urbanization did not appear to degrade water quality. As this was a short-term investigation, they cautioned that this might not be true during the low-flow periods of late summer and early autumn. Presently, the creek is not used for drinking water and primary contact recreation. Industrial and irrigation usage is restricted because of the creek's low flow rate. Livestock watering and the support of aquatic organisms are existing uses.

17. Compliance with the Clean Water Act is required for any Corps project. A Clean Water Act, Section 404(b)(1) evaluation is included in this report (APPENDIX I).

18. <u>Water Supply</u>. The water supply and distribution system in Cape Girardeau is owned by the Missouri Utilities Company. The major water supply source for the Cape Girardeau system is the Mississippi River. The city's water treatment plant on the Mississippi has a capacity of 4.5 mgd. Missouri Utilities also owns and operates three wells in the Cape Girardeau area. One of these ties into the potable water supply system and provides water to an area that is not conveniently served by the water treatment plant. The other two wells provide untreated water to an industrial tract just south of the Little River Diversion Channel. The Cape Girardeau water supply system is adequate for existing needs.

TABLE F-1.

Relationships among mean concentration[1] of physical and chemical parameters observed at three stations in Cape La Croix Creek February through May 1975[2].

PARAMETERS [3]	State Standards (General Use)	STATIONS CLC-1	CLC-5	CLC-11
Flow (cfs)	--		9.56	6.00
Hydrogen Ion Concentration as pH	6.5 - 9.0	7.24	0.40	7.14
Air Temperature (C)	--	14.04	17.00	15.07
Water Temperature (C)	--	13.26	13.34	11.57
Dissolved Oxygen	5.0	7.25	10.76	9.60
Biochemical Oxygen Demand	--	2.77	1.93	1.24
Ammonia Nitrogen	0.5	0.070	0.148	0.027
Organic Nitrogen	--	0.526	0.359	0.259
Nitrate Nitrogen	--	0.570	0.420	0.539
Nitrite Nitrogen	--	0.019	0.018	0.012
Total Phosphate	--	0.320	0.277	0.145
Soluble Orthophosphate	--	0.080	0.082	0.059
Suspended Solids	--	130.3	206.9	21.0
Total Solids	--	365.6	401.0	129.0
Hardness as $CaCO_3$	--	143.0	122.6	56.8
Total Alkalinity as $CaCO_3$	--	126.3	106.3	43.9
Turbidity (FTU)	--	26.0	20.4	18.2
Specific Conductance (umho cm^{-1})	--	242.0	229.7	117.1
*Fecal Coliforms (# per 100 ml)	2000.0	2917.1	2020.6	333.7
Fecal Streptococci (# per 100 ml)	--	8672.0	7012.0	2244.0

[1] Any two means underscored by the same line are not significantly different (0.05 level) by the Modified New Duncan Multiple-Range Test (Kramer 1956). This test was performed following a model 1 analysis of variance.

[2] Raw data for analyses appeared in Southeast Missouri State University (1975).

[3] As mg $liter^{-1}$ unless units are indicated.

*Because of the limited data base and the urban location these values are considered within standard limits.

CULTURAL RESOURCES

19. In 1977, under contract from the St. Louis District, the University of Missouri conducted a cultural resource survey of the Cape Girardeau-Jackson study area. The survey included an on-foot reconnaissance of land along Cape La Croix Creek. A number of archaeological and historical sites were discovered in the field and through documentary research. These sites ranged in age from 5,000 to 1,000 years old and included Archaic, Woodland and Mississippian occupations in addition to standing structures of the 19th century.

20. The survey extended upstream of Cape La Croix Creek approximately 27,000 feet from its confluence with the Mississippi River, and covered the majority of an area 300 feet wide on both sides of the stream. The total area surveyed was approximately 360 acres. Within this area eleven archaeological site locations were identified, including nine prehistoric and two historic sites. Because additional lands were added to the total project universe during the Stage 2 study, an additional 120 acres were surveyed by Southern Illinois University-Edwardsville in 1982. An additional four prehistoric and one historic site were located during this second survey.

BIOLOGICAL RESOURCES

21. A biological inventory of the Cape La Croix Creek Watershed was prepared for the St. Louis District in 1977 under a contract with Midwest Aquatic Enterprises. A summary of that study inventory as it relates to the project area is presented below.

AQUATIC COMMUNITIES

22. Photoplankton, zooplankton, benthos and fish were collected from five sampling stations along the creek system (PLATE F-1). The physical characteristics of the stations at the time of sampling are summarized in TABLE F-2. Physiographicly these stations typify the habitat separations of Ozark uplands (stations 1 and 5), southeastern lowlands (stations 3 and 4), and transitional lands (station 2). The major communities of each of these habitat types is described below. While not specifically sampled, wetland habitats affected by the project are also briefly discussed.

23. Ozark Uplands. Ozark uplands habitat is represented within the project area by the high gradient portions of the creek system (i.e. areas above 120 m.s.l., FIGURE F-1). High water velocities in these areas have resulted in a scoured streambed consisting of bedrock, cobble and gravel.

24. The flora of the uplands is predominately periphytic phytoplankton. Zooplankton is low, except in pool areas. Among the benthic macroinvertebrates, mayflies and midges were found to be abundant. The TABLE F-3 calculations reveal high species diversity/richness values at stations 1 and 5 for phytoplankton and benthos, but low values for zooplankton.

TABLE F-2
AQUATIC HABITAT DESCRIPTIONS

General aquatic habitat descriptions for the aquatic sampling sites investigated during the May and June 1976 survey.

PARAMETERS	STATIONS 1	2	3	4	5
Mean width (m)	2.6	9	3.5	6.5	4
Depth (m)	0.3	0.8	0.6	1.5	0.3
Size (m^2)[1]	315	405	114	500	100
Bottom type	bedrock, cobble, gravel	silt, clay	silt, clay	silt, clay	silt, clay gravel
Estimated velocity ($m\ sec^{-1}$)	1	0.5	0.5	0.5	0.5
Color and clarity	clear brown, turbid	tan, brown, turbid	tan, brown, turbid	tan, brown, turbid	grey brown, slightly turbid
Percent of shore vegetation or other shading	30	90	50	10	75

[1] Area sampled for fishes.

FIGURE F-1

Approximate gradient of Cape La Croix and Walker Creeks, Cape Girardeau County, Missouri, showing locations of the six biological sampling stations (based upon U. S. G. S. topographic maps, 7.5 minute series, Cape Girardeau and Cape Girardeau NE quadrangles, 1967 ed.).

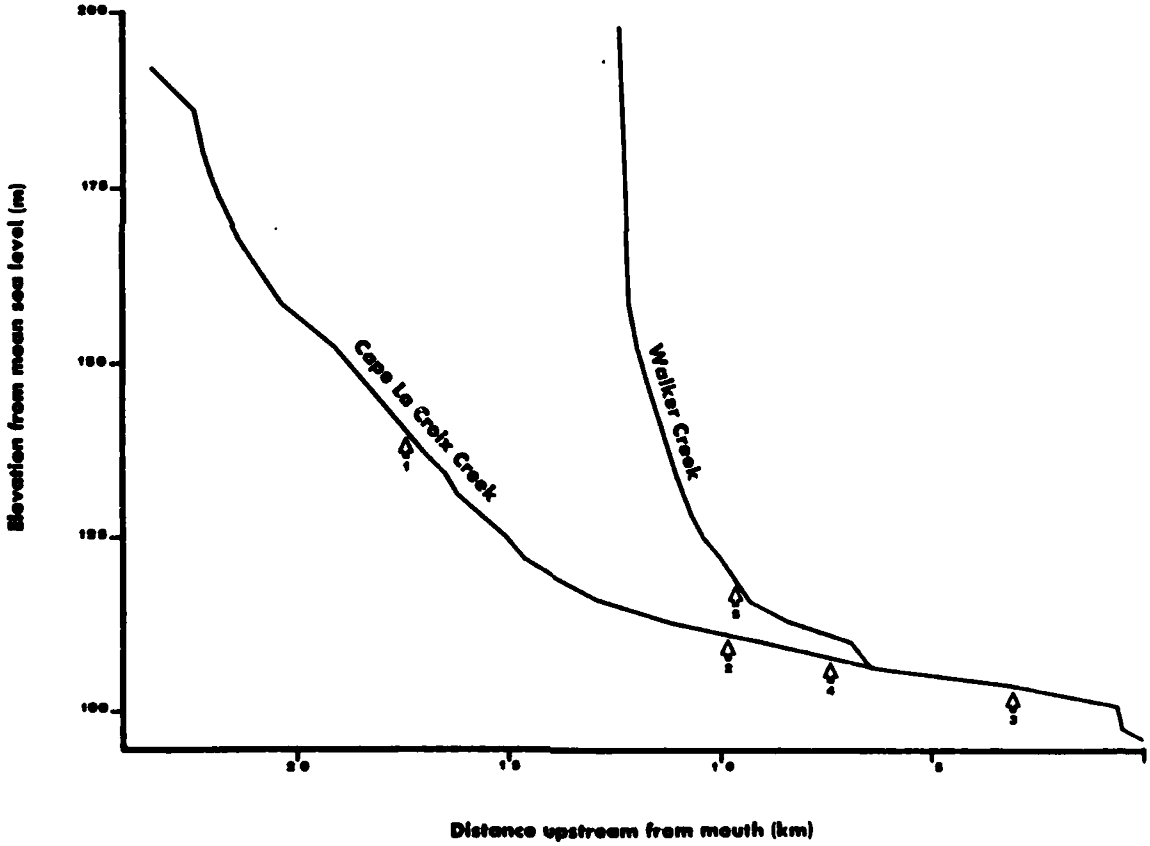

TABLE F-3

SPECIES DIVERSITY AND SPECIES RICHNESS
VALUES FOR PLANKTON AND BENTHOS

Community	STATIONS				
	1	2	3	4	5
Phytoplankton					
Species Diversity	3.5	3.1	3.7	3.0	3.4
Species Richness	3.2	2.9	3.4	2.7	3.1
Zooplankton					
Species Diversity	0	2.3	2.3	1.9	2.2
Species Richness	0	4.6	4.6	1.2	1.2
Benthos					
Species Diversity	2.7	3.4	3.3	2.6	3.8
Species Richness	2.4	3.1	3.0	2.3	3.4

25. The population composition, by family, species diversity, and species richness for each station are summarized in TABLE F-4. In terms of standing crop, the important species of the uplands include the green sunfish, stoneroller and creek chub. Species diversity/richness values were relatively low.

26. Southeastern Lowlands. The southeastern lowlands is the aquatic habitat type that would be most directly affected by the project. The gradient here is low (FIGURE F-1), as is water velocity (TABLE F-2). The substrate consists of silt and clay.

27. The low water velocity permits the development of both phytoplankton and zooplankton. Oligochaetes were significant members of the benthic macroinvertibrate community and reached high densities in the soft sediments. Species diversity/richness values (TABLE F-3) were moderate to high.

28. The most important lowland species were the black bullhead, redfin shiner, red shiner and spotted sucker. Species diversity/richness values were low (TABLE F-4)

29. Transitional Lands. The transitional habitat as might be expected was intermediate in its physical and biological components between Ozark uplands and southeastern lowlands.

30. Wetlands. The wetland type unconsolidated bottom is represented in the project area by two cutoff meanders and two small farm ponds. While not sampled specifically, most farm ponds are stocked initially with largemouth bass and either bluegills or golden shiners or both. Many farm ponds also contain green sunfish, carp, bullheads, and other less desirable species. Properly managed, farm ponds could contribute substantially to the fish and wildlife resource.

31. Overall, the creek showed good species diversity/richness ratings for phytoplankton, plankton and benthos and this is taken as an indication of good water quality. On the other hand, fish species diversity/richness values were quite low, particularly when compared to other Ozark streams. In the lower reaches of the creek system, this decrease can be attributed to the loss of habitat structure caused by prior stream alterations (i.e. removal of riparian vegetation and distrubance of bank and bed materials), and rapid and extreme water level fluctuations due to stormwater diversion.

32. In the upper reaches one can speculate that intermittent flows, small stream size, and some reduction of bank vegetation have contributed to the lower values. From the standpoint of having been the least altered by man, the Ozark uplands is considered to be the most important aquatic habitat of project area.

TABLE F-4
FISH SPECIES DIVERSITY - RICHNESS

Composition (% of total number), species diversity, and species richness of fishes observed in stream and marsh habitats in the Cape La Croix watershed, June 1976.

	STATION				
	1	2	3	4	5
Catostomidae	0.8	-	2.7	0.6	-
Centrarchidae	1.6	2.8	-	1.1	0.4
Cyprinidae	86.6	95.3	95.9	96.0	89.7
Cyprinodontidae	6.1	1.3	1.4	1.7	9.9
Ictaluridae	-	-	-	0.6	-
Percidae	4.9	0.6	-	-	-
Poeciliidae	-	-	-	-	-
Total (%)	100.0	100.0	100.0	100.0	100.0
Number of Specimens	247	320	73	176	233
Species Diversity	1.2	1.5	1.4	0.7	0.9
Species Richness	1.1	1.3	1.2	0.6	0.8

TERRESTRIAL COMMUNITIES

33. Wildlife habitat types of the Cape La Croix Creek project area include approximately 8.4 percent developed habitat (35.8 acres) and 91.6 percent undeveloped habitat (390.4 acres). Only a small portion of the area is classified as wetlands (approximately 7.9 percent or 33.3 acres). The general distribution of the various habitat types of the project area is indicated by PLATE F-2, and for convenience, the areas of this habitat and the percentage of the project area each constitutes is summarized in TABLE F-5. Detailed habitat maps for the specific sites involved in the project are presented in PLATES F-3 and F-4. The terrestrial habitat types are described in detail below.

34. Developed Lands. Of the total acreage of the project area (426.2 acres) 8.4 percent (or 35.8 acres) is developed land.

35. The comprehensive plan for Cape Girardeau indicates that the existing concentration of commercial activities is primarily located within the central city, while industrial uses are situated within the southern portion of Cape Girardeau.

36. Developed lands are of low value to wildlife. Cover is limited to the low lawns, ornamental trees and shrubs, with a few gardens and vacant lots that may provide cover year-round. Wildlife species are limited to a few birds, mammals, and reptiles that are tolerant of human disturbance.

37. Open Lands. Open lands (almost entirely agricultural) represent 61.9 percent of the project area (264.2 acres). Most of this habitat is northwest of the city. The intensive agriculture of the watershed limits the presence of old fields, although some of this habitat can be found at the Meander and Hopper Road sites (PLATE F-3). Most available land is either under cultivation, pastured, or lying fallow as mowed fields.

38. Nearly one-half (40 percent) of the total non-fish vertebrates reported for all habitats occur here.

39. Because of the intensity of agriculture, virtually all suitable land is under cultivation or maintained as pasture. Hence, further expansion of agricultural habitat is unlikely. In fact, expansion of urban habitats presently is reducing the amount of agricultural habitat.

40. Food and cover may be limiting to wildlife in agricultural habitat. Monoculture of row crops produces large amounts of food which may be suitable to only a few wildlife species. In addition, intensive cultivation reduces the amount of idle land. Hence, the food which exists may be largely unavailable to species which are reluctant to venture far from cover.

TABLE F-5

Summary of the extent of various wildlife habitat types in the Cape La Croix Creek project Area.

HABITAT TYPE	AREA[1]	PROJECT[2] AREA
Developed Land	35.8	8.4
Open Land	264.2	61.9
Upland Forest	5.9	1.4
Bottomland Forest	87.0	20.4
Wetlands		
Emergent Wetland	5.0	1.2
Unconsolidated Bottom	3.3	0.8
[3]Forested Wetland	25.0	5.9
Cape La Croix Creek & Tributaries	11.0 mi.	

[1] Units are in acres unless otherwise indicated.

[2] Based upon a total project area acreage of 426.2 acres.

[3] This is not part of the Federal project area per se; data is presented for these lands since they are discussed in a later appendix section relative to an EQ recommendation to the local sector.

41. Upland Forest. Upland forest comprises 1.4 percent of (5.9 acres) of the project area. The predominate canopy species includes sugar maple (mean 30.1 percent cover) plus oaks, hickories, and elms as important but less abundant species.

42. Upland forest habitat supports a large number of terrestrial vertebrate species. One hundred seventy-two vertebrate species are known or likely to occur in upland forest habitat.

43. The forest edge is especially important. Numerous species are confined to this region.

44. Bottomland Forest. Flood plain forest within the project area exists as a thin band of woodland adjacent to the creek. This habitat covers 20.4 percent (or 87.0 acres) of the total project area.

45. Two hundred and four vertebrate species are noted for the bottomland forest habitat along Cape La Croix Creek and its tributaries including 25 amphibians, 41 reptiles, 103 birds, and 35 mammals.

46. The riparian bottomland forest community along the Cape La Croix Creek is especially important as a corridor for wildlife movement. Many wildlife species are wary of open areas and rely upon these corridors as avenues for dispersal and movement. In the upper reaches of the watershed, this vegetation has been little disturbed by man. It has developed in areas, which for reasons of access, slope, and/or flooding, are unsuited for other uses. It is absent or very sparse in the middle reaches along the creek due to urban development. In the lower reaches of the watershed, streamside clearing has produced a discontinuous band of riparian vegetation, thereby limiting its use as a wildlife corridor.

47. Emergent Wetland. Two palustrine emergent wetlands, with a combined acreage of 5.0 acres, are located at the junction of U.S. Highway 61 and Missouri Highway 74. This represents 1.2 percent of the project area. This habitat was characterized by the presence of arrow arum and lizard's-tail occurring as the predominant.

48. The non-fish vertebrate fauna of emergent wetlands includes one hundred-nineteen species. Among these are nearly two-thirds of all amphibians, nineteen of 29 species, listed for the Cape La Croix Creek watershed. Especially abundant are the cricket and chorus frogs and the "true" frogs (Rana).

49. The extent of these wetland habitats is so small that their importance to the overall ecology of the project area might be overlooked. Their contribution is as a refuge for many small species, especially among the amphibians and turtles, which do not exist elsewhere in the watershed.

50. Unconsolidated Bottom Wetland. Palustrine unconsolidated bottom wetland habitat is represented by two small cutoff meanders (2.1 acres combined) surrounded by bottomland forest cover, and two small farm ponds (1.2 acres) located in open pastureland.

51. These wetlands are devoid of aquatic vegetation and is very similar to areas where emergent vegetation has developed.

52. The non-fish vertebrate fauna of this wetland type is similar to that of emergent wetland areas. A total of 111 species are noted, including seventeen species of amphibians, 25 species of reptiles, 52 species of birds, and seventeen species of mammals.

53. Forested Wetland. Seasonally flooded palustrine forested wetland is represented by two small tracts of woodland (25.0 acres combined), one northeast and one southwest of the junction of US Highway 61 and Missouri Highway 74. Only the northeast section (10 acres) is strictly within the confines of the Cape La Croix Creek watershed boundaries.

54. The overstory vegetation consists of black willow and ash (*Fraxinus* sp.). Although reproduction was occurring among the willow, the large ash trees were nearly all dead. It would appear that an abrupt change in the water regime has occurred within this wetland to have seriously affected the ash. Bottonbush and swamp rose comprise the shrubby understory layer.

55. Forested wetland habitat in the watershed has many faunal differences from the other wetland types. The two tracts noted in the study area represent a relict natural area and a refuge for many species which do not exist elsewhere in the watershed. The size of the these tracts, however, preclude the existence of many animal species which require large ranges. Rather species characteristics of the forested wetlands are represented by numerous invertebrate and a few small and secretive vertebrate species. In practical terms, this forested wetland is important as a relict natural area.

56. Cape La Croix Creek and Tributaries. About 11.0 mi of Cape La Croix Creek and its tributaries are contained between the upper and lower limits of the project area.

57. Aquatic vegetation is limited principally to attached microflora in Cape La Croix Creek and its tributaries. Rooted macrophytes are notably absent.

58. Seven amphibians, 26 reptiles, 103 birds, and 17 mammals may utilize the stream for food and cover.

59. The aquatic community of Cape La Croix Creek may be as productive per unit area as adjacent agricultural land. In the presence of an agriculture limited to two or three principal crops, the diversity in

available food provided by the creek's fishes, crayfishes, and, especially emerging aquatic insects is attractive to many species of terrestrial wildlife. Virtually all groups contain common species which depend upon these food sources.

60. Finally, Cape La Croix Creek and its tributaries are important to the terrestrial community as a source of drinking water.

PESTIFEROUS PLANTS AND ANIMALS

61. The pestiferous plants and animals known or thought to occur in the Cape La Croix Creek project area include poison ivy, the brown recluse spider, the wood and lonestar ticks, and mosquitoes. A check with the Missouri Division of Health has revealed no incidence of public health problems in Cape Girardeau County from these sources in recent years.

THREATENED, RARE AND ENDANGERED SPECIES

62. TABLE F-6 summarizes federally listed threatened or endangered species and state listed rare or endangered species that may occur within the project area. This table was compiled from two sources: (1) a letter from the Regional Director of the U.S. Fish and Wildlife Service (APPENDIX H) indicating federally listed species about which the District should be concerned and (2) an extraction from the statewide listing by Nordstrom et al. (1977), of species for Cape Girardeau County.

63. A state rare species or subspecies is one that is present in Missouri in small numbers. If its environment worsens its continued presence in the state may become endangered. Many of the species listed as rare in Missouri are present in substantial numbers in other parts of their range, and may never have ranged far into the state or occurred in substantial numbers. They are listed because their presence enriches and diversifies the state's environment. The designation "rare," as defined here, is not necessarily synonymous with "threatened" as that word is used in federal legislation.

TABLE F-6

FEDERAL THREATENED/ENDANGERED AND STATE RARE/ENDANGERED SPECIES THAT MAY OCCUR WITHIN THE PROJECT AREA

Species	Mo. Dept. of Conservation	U.S. Dept. of the Interior	Special Notations
Fishes			
Notropis emiliae (Pugnose minnow)	E		7
Amphibians and Reptiles			
Macroclemys temminckii (Alligator Snapping Turtle)	R		2,3,10
Crotalus horridus (Canebrake Rattlesnake)	E		1,3,10
Birds			
Haliaeetus leucocephalus (Bald Eagle)		E	1,5,7,8,11
Circus cyaneus (Marsh Hawk)	E		3,4,6,8,11
Accipiter cooperii (Cooper's Hawk)	E		4,5,6,10,11
Pandion haliaetus (Osprey)	E		4,5,10,11
Falco peregrinus (Peregrine Falcon)		E	4,5,11
Mammals			
Mustela frenata (Long-Tailed Weasel)	R		4,5
Plants			
Peltandra virginica (Arrow Arum)	R		1,2,3,9
Thalia dealbata (Thalia)	E		2,3

TABLE F-6
(Continued)

FEDERAL THREATENED/ENDANGERED AND STATE RARE/ENDANGERED SPECIES THAT MAY OCCUR WITHIN THE PROJECT AREA

Special Notations (Based on the 1977 biological inventory data of Midwest Aquatic Enterprises):

Suitable Project Area Habitat

1. Forested Wetland
2. Unconsolidated Bottom Wetland
3. Emergent Wetland
4. Old field
5. Upland forest
6. Agricultural
7. Cape La Croix and Tributaries

Probable Occurrence within Project Area

8. Known to occur, documented sightings
9. Presence verified during 1977 biological inventory
10. Likely to occur in or near project area
11. Seasonal occurence

FUTURE WITHOUT ENVIRONMENTAL CONDITIONS

LAND RESOURCES

64. No significant agricultural expansion is expected for the future without the project, since most usable acreage is already in such use. The main factor in future land use change will be urbanization. It is predicted that by the year 2040 nearly all agricultural use within the project area will have ceased.

65. Aesthetic qualities will change in the future as the project area shifts from its more natural rural appearance to that of a typical urban setting.

AIR RESOUCES

66. The air quality of the project area should continue to attain Federal (Personal Communication with Mr. Langston of the Kansas City Office of the US Environmental Protection Agency) and state (Personal Communication with Mr. Raymond of the Missouri Department of Natural Resources) minimum air quality standards. Ambient noise levels will increase as future urbanization spreads. The noise levels typically found within industrial/commercial areas is about 70 dBA and about 60 dBA in residential sections. No climatic changes are expected.

WATER RESOURCES

676 Future planning efforts under the 1972 Water Pollution Control Act Amendments (PL92-500) should ensure that future significant adverse effects on the areas existing water quality does not occur.

68. Non-point source pollution could potentially increase in the future as storm water runoff from newly urbanizing areas contributes to the problem. In more rural sections of the area, stream bank erosion, row crops, livestock husbandry septic tank malfunctions and direct house-to-stream sewage will contribute to non-point sources of pollution at about its existing level. Significant future departures from the existing pollution level is not expected since this area would probably be designated a "208 area" and would receive appropriate remedial attention.

69. A major expansion of Cape Girardeau's water supply system will have to be implemented if the city's projected water demands are to be met. The Missouri Utilities Company has indicated that it does intend to expand its facilities to meet the future water supply needs of Cape Girardeau.

CULTURAL RESOUCES

70. All project area sites identified during the 1977 and 1982 archaeological investigations are in private ownership, and as such are subject to impacts from a variety of land use patterns. Future impacts

are likely to include continued cultivation (and associated erosion) and urban development. Urban development is the most serious threat to the resource because it usually involves soil removal and ground surface preparation.

BIOLOGICAL RESOUCES

71. In the future without the project urbanization is expected to be the prime force altering the nature of the project area's biological resources. The comprehensive plan for Cape Girardeau (Hunt et al., 1975) indicates that the existing concentration of commercial activities is primarily located within the central city, along Kingshighway and around the interchange at Interstate 55 and Route K. Industrial uses are situated within the southern portion of Cape Girardeau. In the future, commercial land use will be concentrated within the central business district, the shopping center around Kingshighway and William Street and the developing commercial complex near I-55 and Route K. Smaller units are expected along Route 74, on US 61 and also in the north. An extensive area for future industrial development is possible within the southern part of Cape Girardeau. Other areas for industrial development are provided by Kingshighway and Independence St. Residential development is anticipated to continue to expand into the western and northwestern portions of the city.

72. An estimation of the project area habitat acreage shifts that are expected to accompany this future trend of urbanization is summarized by habitat type in TABLE F-7. TABLE F-8 provides a similar summary, but this time it is broken out by specific locations within the project area. It can be seen that for all project locations, except for the detention site, urbanization will have exerted its full effect on the project area by the year 2000. By the year 2040, the detention area will also be developed. The characteristics of the future habitat types would be expected to be similar to those same habitat types described for the existing conditions.

73. In terms of wildlife, the value of the project area will greatly decline as urbanization spreads. Creekside bottomland forest with a near 70 percent existing cover in the rural sections will probably decline to a 50 percent level in future residential settings and close to zero percent coverage within industrial/commercial settings, wetlands, openland, and upland habitats to urban development (primarily residential) will likewise result in a net loss of food and cover for wildlife. Animal species more characteristic of developed areas such as the robin, cardinal, squirrel, and rabbit will gradually replace the numerous species that presently characterize the more rural settings of the project area. The loss of undeveloped habitat will result in a loss of wildlife and a loss of opportunity for observing wildlife within an urban setting.

TABLE F-7. SUMMARY OF PROJECT AREA "FUTURE WITHOUT" HABITAT CONDITIONS

Habitat Type	1980		2000		2020		2040-2090	
	Acres	% Project Area	Acres	% Project Area	Acres	% Project Area	Acres	% Project Area
Development	35.8	(8.4)	179.0	(42.0)	269.6	(63.3)	357.2	(83.8)
Open Land	264.2	(61.9)	182.0	(42.7)	110.4	(25.9)	39.0	(9.2)
Upland Forest	5.9	(1.4)	5.9	(1.4)	2.9	(0.7)	0.0	(0.0)
Bottomland Forest	87.0	(20.4)	56.5	(13.3)	43.3	(10.2)	30.0	(7.0)
Wetlands								
Emergent Wetlands	5.0	(1.2)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
Unconsolidated Bottom	3.3	(0.8)	2.8	(0.6)	0.0	(0.0)	0.0	(0.0)
Forested Westland	25.0	(5.9)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)

Total project area is 426.2 acres.

TABLE F-8. "FUTURE WITHOUT" HABITAT CONDITIONS
FOR SPECIFIC PROJECT AREA LOCATIONS

Project Area Location	Future Without Conditions			
	1980 Acres	2000 Acres	2020 Acres	2040-2090 Acres
Hopper Road Site (See PLATE F-3)				
Bottomland Forest	18.0	0.0	0.0	0.0
Openland	68.0	0.0	0.0	0.0
Development	0.0	86.0	86.0	86.0
TOTALS	86.0	86.0	86.0	86.0
Dry Detention Site (See PLATE F-4)				
Bottomland Forest	41.5	41.5	28.3	15.0
Openland	143.0	143.0	71.4	0.0
Development	8.5	8.5	97.6	185.2
Farm Ponds	1.3	1.3	0.0	0.0
TOTALS	200.2	200.2	200.2	200.2
Meander Site (See PLATE F-3)				
Bottomland	10.5	0.0	0.0	0.0
Openland	14.1	0.0	0.0	0.0
Development	0.0	25.2	26.7	26.7
Cutoff Meanders	2.1	1.5	0.0	0.0
TOTALS	26.7	26.7	26.7	26.7
Building Relocation Sites				
Development	14.3	14.3	14.3	14.3
TOTALS	14.3	14.3	14.3	14.3
Wetlands Site (See PLATE F-2)				
Emergent Wetlands	5.0	0.0	0.0	0.0
Forested Wetland	25.0	0.0	0.0	0.0
Development	0.0	30.0	30.0	30.0
TOTALS	30.0	30.0	30.0	30.0

TABLE F-8. "FUTURE WITHOUT" HABITAT CONDITIONS
FOR SPECIFIC PROJECT AREA LOCATIONS
(Continued)

Project Area Location	Future Without Conditions			
	1980 Acres	2000 Acres	2020 Acres	2040-2090 Acres
Riparian Corridor				
Bottomland Forest - I/C	1.0	0.0	0.0	0.0
Bottomland Forest - Residential	4.0	14.0	14.0	14.0
Bottomland Forest - Rural	11.0	0.0	0.0	0.0
Bottomland Forest - Parks	1.0	1.0	1.0	1.0
Open Land - I/C	7.0	15.0	15.0	15.0
Open Land - Residential	10.0	16.0	16.0	16.0
Open Lands - Rural	14.0	0.0	0.0	0.0
Open Lands - Parks	8.0	8.0	8.0	8.0
Development	13.0	15.0	15.0	15.0
Water	0.0	0.0	0.0	0.0
TOTALS	69.0	69.0	69.0	69.0
GRAND TOTAL	426.2	426.2	426.2	426.2

74. Future flood control activities by the local sector along with increased urban development will probably maintain the Southeastern lowlands aquatic habitat in its existing physically degraded state. Urbanization represents the principal future threat to Ozark uplands habitat. Undesirable activities include removal of streamside cover, clearing of adjacent areas, diversion of stormwater, and the establishment of single-family septic fields. The expected life of the two farm ponds, because of sedimentation from agricultural activities, is 25 years. The old cutoff meanders of Cape La Croix Creek although they are associated with forested cover will probably dry out on occasions, and this will tend to limit their biological value.

75. For endangered species, no significant change from existing conditions is expected in the future without the project. Bald eagles are expected to only occasionally use trees along the project's affected waterway and the peregrine falcon will occasionally use the area as a migrant. See Appendix H for further details.

ENVIRONMENTAL PROBLEMS, NEEDS AND OPPORTUNITIES

TERRESTRIAL HABITAT IMPROVEMENT

76. Extensive urbanization within the watershed has reduced the amount of undeveloped areas that are the primary habitats for terrestrial wildlife. Particularly significant has been the loss of bottomland forest habitat. This cover type is of fairly limited distribution, occurring only in the flood plains of rivers and creeks. Riparian bottomland forest has been eliminated from much of the creek within and below the city of Cape Girardeau. The net result has been a loss of food, cover and travel lanes for wildlife.

77. The loss of terrestrial habitat within an urban context has also created a biologically unproductive environment with little opportunity for observing wildlife.

78. Publicly accessible habitat areas close to an urban setting provides opportunities for nonconsumptive wildlife use. Woody vegetation is the prime habitat element that must be present to support diverse productive populations of birds that are the focal point for non-consumptive wildlife use. Except for backyard settings, the City presently provides little opportunity for this type of activity.

79. Project measures designed to provide access to publicly owned and managed habitat areas, or that improve backyard habitat areas would greatly enhance conditions for wildlife and also provide opportunities for non-consumptive wildlife use.

AQUATIC HABITAT IMPROVEMENT

80. A healthy aquatic ecosystem will have a diversity of habitat types. Only a few pools which provide water, food and shelter for aquatic organisms remain in the southeastern lowlands portion of Cape La Croix Creek. The removal of riparian trees have allowed the water in the creek to increase in temperature during the summer, having an adverse impact on the aquatic ecosystem. Also, trees provide habitat for food organisims (insects, caterpillars, etc.), provide bank stabilization and create pools by backing up water or diverting the water so that it will create a pool. The decrease in aquatic and riparian habitat results in a decrease in fish species and populations. The loss of these habitats has resulted from past channelization efforts, increased runoff, urban development and farming practices. There is a need and an opportunity to develop project measures that reduce or reverse the effects of this habitat degradation.

EROSION CONTROL

81. Severe bank erosion is evident at numerous locations along the creek system, particularly at the sharper bends along the lower section of Cape La Croix Creek. Contributing to this problem has been the loss of bank stabilizing vegetation due to past flood control activities, and the encroachment of urban/agricultural development on the flood plain. The effect of increased runoff due to the watershed's expanding development has likewise intensified the problem. There is a need to provide erosion control along the creek.

WASTEWATER MANAGEMENT AND WATER QUALITY

82. Cape Girardeau's Master Plan indicates that a considerable increase in the area's industrial, commercial and residential development can be expected in the near future. This growth is anticipated to bring with it a host of potential point and nonpoint sources of pollution. It is assumed that existing and future needs to improve water quality conditions will be satisfied through the enforcement by other agencies of all Federal and State Clean Water Laws.

WATER SUPPLY

83. The extensive groundwater resources and the proximity of the Mississippi River and the Little River Diversion Channel are evidence that the future water supply demands of the study area can surely be met. The problem will be timely implementation of the most economic water supply systems.

ENDANGERED SPECIES

84. The protection of federally threatened and endangered species and their habitat was made a national priority in 1973 with the enactment of the Endangered Species Act. In a letter dated June 3, 1979 the U.S. Fish and Wildlife Service notified the District that two Federally endangered

species - the bald eagle and the peregrine falcon could occur within the project area. The District's biological assessment (APPENDIX H) indicates that while these two species may occasionally be found, it is doubtful because of the high extent of development that they utilize the area to any significant extent. No habitat critical to these species has been identified within the project area.

WETLANDS

85. The forested wetland located near the junction of Highways 61 and 74 is a relic of what was once an abundant resource within the Mississippi River flood plain. Most of the flood plain wetlands have been lost as a result of draining and/or filling for industrial, commercial, residential and agricultural purposes. Portions of the forested wetland area are now being filled in, and within the near future it is anticipated that this entire area will be lost to industrial development.

LITTER AND DEBRIS CONTROL

86. A need exists to better control dumping and littering in and along the stream corridor. Such debris acts as a hydraulic impediment and degrades the aesthetic and environmental quality of the watershed.

CULTURAL RESOURCE PROPERTIES

87. During the 1977 and 1982 Cultural Resource surveys, archeological and historical properties were identified. Sites are being lost as a result of urbanization and other land use changes. Since the implementation of a project could also impinge upon such areas, there is both a project need and a project opportunity to protect such locations. Opportunities are afforded by site evaluations, careful planning and coordination and resource recovery mechanisms.

ENVIRONMENTAL PLANNING OBJECTIVES

88. The planning objectives were to protect or enhance the following elements where possible:

a. Terrestrial habitats (particularly flood plain forest).
b. Aquatic habitats.
c. Erosion control.
d. Water quality.
e. Endangered species and their habitats.
f. Wetlands.
g. Litter and debris control.
h. Cultural sites.

ENVIRONMENTAL PLAN FORMULATION

89. The environmental plan formulation is discussed herein under the topics of Flood Control Configuration and Development of EQ Features.

FLOOD CONTROL CONFIGURATION

90. Six detailed plans were developed as the final array of alternative solutions, namely, the NS, SPF, NED, EQ, A, and Recommended Plans. The basic flood control configuration of each plan was assigned following a preliminary hydrological/economic analysis of the effects of numerous displays of flood control management measures acting separately or in combination. The rationale for the selection of the NED, SPF, NS, A, and Recommended flood control configurations is explained in detail in APPENDIX B of this report.

91. TABLE F-9 indicates the method utilized for identifying a suitable flood control base upon which the EQ plan features could be added. Preliminary planning efforts identified 8 major categories of flood control options. TABLE F-9 rates each of these options using 3 critical criteria; namely, economic viability, relative EQ performance, and percent damage reduction. A rating value of 1 assigned to any of the options was regarded as a fatal flaw. Accordingly, only options (5)(6) and (7) appeared to be viable. Because of its higher overall performance, option (6) with channelization extending on Cape La Croix to RM 5.1 was choosen as the EQ base configuration.

TABLE F-9 Prioritization of the Flood Control Base Configurations for the EQ Plan

Type of Option	Parameter A	Parameter B	Parameter C	Total
(1) *Building Removals	1	3	1	5
(2) Single Detention Only	3	2	1	6
(3) Double Detentions Only	2	2	1	5
(4) Channelization on Both Creeks (Cape LaCroix Channel untruncated)	2	1	3	6
(5) Channelization on Both Creeks (Cape LaCroix Channel truncated)	2	2	3	7
(6) Detention(s) Plus Channelization on Both Creeks (Cape LaCroix Channel from R.M.2.8 to 5.1)	2	3	3	8
(7) Detention(s) Plus Channelization on Both Creeks (Cape LaCroix Channel from R.M. 2.8 to 3.8))	2	3	2	7
(8) Detention Plus Channelization on Walker Creek Only	3	3	1	7

Parameters:
(A) Economic Viability (B) Relative EQ Performance
(C) Flood Damage Reduction

Criteria for the Prioritization of the Flood Control Base Configuration for the EQ Plan:

*(A) Economic Viability
1 = Preliminary B/C (1.0
2 = Preliminary B/C) 1.0 (2.0
3 = Preliminary B/C) 2.0
* Includes all properties affected by the 10-year flood event.

**(B) Relative EQ Performance

1 = Much aquatic habitat would be disturbed, and/or little undeveloped terrestrial habitat would be preserved.
2 = Some aquatic habitat would be disturbed, and/or some undeveloped terrestrial habitat would be preserved.
3 = Little aquatic habitat would be disturbed, and/or much undeveloped land would be preserved.

*(C) Flood Damage Reduction (%)

1 = (80%
2 =) 80% (90%
3 =) 90%

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* These parameters address the planning objectives requiring an economically viable and functionally effective project solution.

** Creek habitat impacts were identified in Stage 2 as potentially the most significant adverse impact related to the construction of a project.

DEVELOPMENT OF EQ FEATURES

92. Based on preliminary data, it was quite evident that the NS and SPF plans were not economically justified. In addition, neither plan provided unique environmental opportunities that would justify BCR's below unity. Because EQ features generally do not provide significantly positive contributions to the BCR, a planning team decision was made to not develop detailed EQ features for these two plans.

93. For the four remaining plan options (i.e., NED, EQ, Recommended plans and Plan A), a comprehensive listing of approximately 27 potential EQ management measures were developed. These measures are described in detail at the end of this plan formulation section. Each measure was designed to address one or more of the EQ problems identified during planning; that is, terrestrial habitat loss, aquatic habitat loss, erosion, water quality degradation, endangered species preservation, archaeological/historical site preservation, wetlands loss, and litter.

94. Next, the EQ performance and cost associated with each potential measure was assessed by the District. Relative EQ performance was ascertained with the aid of TABLE F-10. In this table, each potential measure was subjectively graded for its relative ability to address a specific EQ objective. Maximal conditions for comparison's sake is the combined effect of all applicable measures working together to address a given objective. A summarization of the EQ measures initially applied to the EQ plan is provided in TABLE F-11. This table also indicates the EQ performance, cost and planning decision as to the incorporation or deletion of each measure from the final version of the plan.

TABLE F-10 PRIORITIZATION OF EACH EQ MEASURE BASED ON ITS RELATIVE CONTRIBUTION TO THE FULFILLMENT OF THE ENVIRONMENTAL PLANNING OBJECTIVES

	EQ OBJECTIVES T	A	E	WQ	ES	W	LD	C	TOTAL	PRIORITY
Riparian Corridor										
Cape La Croix (Mouth - R.R.)	1	2	2	1	1	0	0	0	7	L
Cape La Croix (R.R. - Sprigg)	1	1	2	1	1	0	0	0	6	L
Cape La Croix (Sprigg - Hwy 74)	2	5	7	3	3	0	0	0	20	M
Cape La Croix (Hwy 74 - Wilson)	2	5	7	3	3	0	0	0	20	M
Cape La Croix (Wilson - Bloomfield)	2	4	5	2	3	0	0	0	16	M
Cape La Croix (Independence - Hopper)	2	4	2	1	3	0	0	0	12	L
Cape La Croix (Hopper - Hwy 61)	3	6	4	2	4	0	0	0	19	M
Cape La Croix (Hwy 61 - Hwy W)	3	5	5	2	4	0	0	0	19	M
Cape La Croix (Hwy W - Del)	3	5	7	3	4	0	0	0	22	M
Walker (Broadway - Merrietta)	3	3	4	2	4	0	0	0	16	M
Walker (Merrietta - Cape Rock)	3	3	4	2	4	0	0	0	16	M
One Bank Channel Construction	2	1	0	0	0	0	0	0	3	L
Detention Park	14	0	0	0	6	0	0	0	20	M
Hopper Road Park	12	0	9	5	6	0	0	0	32	H

EQ Objectives:

(T) Terrestrial Habitat
(A) Aquatic Habitat
(E) Erosion Control
(WQ) Water Quality
(ES) Endangered Species
(W) Wetlands
(LD) Litter and Debris
(C) Cultural Sites

EQ Priorities:

L - Low (0-15)
M - Moderate (16-30)
H - High (>30)

TABLE F-10 PRIORITIZATION OF EACH EQ MEASURE BASED ON ITS RELATIVE CONTRIBUTION TO THE FULFILLMENT OF THE ENVIRONMENTAL PLANNING OBJECTIVES (CONTINUED)

	EQ OBJECTIVES								TOTAL	PRIORITY
	T	A	E	WQ	ES	W	LD	C		
Meander Site Park	10	5	9	11	4	20	0	0	59	H
Walker Creek Bottomland	3	0	5	6	1	0	0	0	15	L
Wildlife Management	16	0	23	11	9	0	0	0	59	H
Urban Wildlife Program	18	0	0	0	0	0	0	0	18	M
Wetlands Preserv. Recommendation	0	0	5	5	10	80	0	0	100	H
*Endangered Species Consultation	0	0	0	0	30	0	0	0	30	H
Riffle/Pooling Device	0	10	0	0	0	0	0	0	10	L
Pooling Device	0	5	0	0	0	0	0	0	5	L
Fish Pond Improvements	0	16	0	0	0	0	0	0	16	M
Hillside Fish Pond	0	15	0	0	0	0	0	0	15	L
Support for Pollution Control	0	5	0	35	0	0	0	0	40	H
Trash Removal	0	0	0	5	0	0	100	0	105	H
*Cultural Site Eval. & Recovery	0	0	0	0	0	0	0	100	100	H

EQ Objectives:

(T) Terrestrial Habitat
(A) Aquatic Habitat
(E) Erosion Control
(WQ) Water Quality
(ES) Endangered Species
(W) Wetlands
(LD) Litter and Debris
(C) Cultural Sites

EQ Priorities:

L - Low (0-15)
M - Moderate (16-30)
H - High (>30)

* Measures required by Federal Statutes.

TABLE F-11 - DECISION REGARDING EQ MEASURES TO BE RETAINED IN THE FINAL ENVIRONMENTAL QUALITY PLAN

Description	* EQ Performance	Cost (Per Acre)	Decision	Remarks
Riparian Corridor				
Cape La Croix (Mouth - R.R.)	L	M	D	Reach is below project area.
Cape La Croix (R.R. - Sprigg)	L	M	I	
Cape La Croix (Sprigg - Hwy 74)	M	M	I	
Cape La Croix (Hwy 74 - Wilson)	M	M	I	
Cape La Croix (Wilson - Bloomfield)	M	H	I	Cost shared with recreation.
Cape La Croix (Independence - Hopper)	M	H	I	Cost shared with recreation.
Cape La Croix (Hopper - Hwy 61)	L	H	I	Cost shared with recreation.
Cape La Croix (Hwy 61 - Hwy W)	M	M	I	
Cape La Croix (Hwy W - Det)	M	L	I	
Walker (Broadway - Merrietta)	M	M	D	
Walker (Merrietta - Cape Rock)	M	M	D	
One Bank Channel Construction	L	Z	I	
Detention Park	M	L	I	Cost shared with recreation.
Hopper Road Park	H	M	I	Cost shared with recreation.

Code: Z = Zero Cost
L = Low EQ Performance or Cost
M = Moderate EQ Performance or Cost
H = High EQ Performance or Cost

D = Deleted Item
I = Incorporated Item

* EQ Priorities are from TABLE F 11

TABLE F 11 DECISION REGARDING EQ MEASURES TO BE RETAINED IN THE FINAL ENVIRONMENTAL QUALITY PLAN (CONTINUED)

Description	* EQ Performance	Cost (Per Acre)	Decision	Remarks
Meander Site Park	H	H	I	Cost shared with recreation.
Walker Creek Bottomland	L	H	D	
Wildlife Management	H	M	I	
Urban Wildlife Program Recommendation	M	Z	I	
Wetlands Preservation Recommendation	H	Z	I	
Riffle/Pooling Device	L	H	I	Recommended by U.S. Fish and Wildlife Service.
Pooling Device	L	L	I	
Fish Pond Improvements	M	M	I	A separable EQ cost.
Hillside Fish Pond	L	H	D	Although recommended for inclusion by the USFWS, the District feels the measure is cost prohibitive.
Support for Pollution Control	H	Z	I	
Trash Removal	H	L	I	

Code: Z = Zero Cost
L = Low EQ Performance or Cost
M = Moderate EQ Performance or Cost
H = High EQ Performance or Cost

D - Deleted Item
I = Incorporated Item

* EQ Priorities are from TABLE F 11

95. In order to achieve a proper balance between project objectives and a goal of achieving a BCR equal to or greater than 1.2, it was found necessary to impose at least some funding constraint for the incorporation of the EQ features. However, because of a high flood control BCR and the inherent emphasis of the plan on environmental quality, nearly all (22) of the EQ features applied maximally to this plan were retained.

EQ FEATURES OF ALTERNATIVE PLANS

96. Since no EQ features were recognized as potentially generating tangible benefits in excess of their costs, no such features were included in the NED Plan. The Recommended Plan does not differ from the NED Plan except for the inclusion of certain features that would result in no cost to the Corps of Engineers. This includes the Urban Wildlife Program Recommendation, the Wetlands Preservation Recommendation, and Support for Pollution Control, all of which could be enacted by some other Federal, state or local agency. Likewise, one bank channel construction is without associated cost and would be implemented as part of the recommended project plan. Plan A which sought to provide the highest level of flood protection possible, with a BCR still near unity, provided an opportunity to include many of the EQ features displayed in the EQ Plan.

97. The basic features of the NED, EQ, Recommended plans and Plan A are illustrated in PLATES F-6, F-7, F-9 and F-10, respectively.

DESCRIPTION OF EQ FEATURES

98. Riparian Corridor. This measure entails the acquisition of certain undeveloped sections of stream-side corridor along Cape La Croix Creek. Where present, the corridor would normally be 20 feet wide on a given bank.

99. This measures removal of riparian land from the threat of future development, and its compatability with the wildlife management feature would help address the previously stated need for reducing losses to terrestrial habitat. Benefits would accrue not only to wildlife, but in conjunction with recreation trails, would provide a unique opportunity for observing wild animals within an urban setting. Improvements in the aquatic habitat and erosion control would also be expected.

100. One Bank Channel Construction. This measure would require that channel construction along Walker Creek be restricted to one bank. By minimizing damages to the existing riparian vegetation, this feature would address the need for reducing losses to terrestrial habitat. Some aquatic habitat improvement would also be expected. The measure would also tend to diminish the aesthetic impacts of channelization along this reach of creek.

101. Detention Park. This measure calls for the use of the detention site as a park. The existing land use of the area is shown in PLATE F-4.

102. Against a background of probable future development, this land purchase would help reduce the loss of terrestrial habitat within an urban context. Opportunities for the observation of wildlife near to home would be greatly increased to the cities residents. This opportunity could be maximized by the further adoption of the wildlife management measure.

103. Hopper Road Park. This measure would entail the purchase of an 86-acre floodplain tract lying between Auburn Road, Hopper Road and US Highway 61 (PLATE F-3). The rationale for this measure would be the same as that described for the detention park measure.

104. Meander Site Park. This measure would provide for the purchase of 27 acres of floodplain east of Cape La Croix Creek between RM 2.2 and 2.8 (PLATE F-3). The needs addressed by this measure are the same as that indicated for the Hopper Road bottomland site.

105. Walker Creek Bottomland. This 22-acre tract lies along the east bank of Walker Creek between R.M. 0.9 and 1.7. Although, EQ purchase of this area would address the same needs as the Hopper Road site, the Walker Creek bottomland is smaller and terrestrially of much lower existing habitat value.

106. Wildlife Management Measure. This measure would ensure that the undeveloped lands provided by other project features would be able to support a diverse and abundant wildlife population.

107. This measure addresses the need for reducing losses to terrestrial habitat and provides the public with enhanced recreational opportunities for observing wildlife in a natural setting.

108. Since avian species are regarded as the key component of non-consumptive wildlife use, the management effort would necessarily emphasize birds. The final plan would be likely to include the following: hedgerows, fence rows, minimized disturbance to mature woodlands, increased snag production, food patches, farm leasing agreements, and creekside plantings.

109. Urban Wildlife Program. Opportunity for wildlife habitat development also exists on the residential land in the watershed. As of 1974, there were approximately 11,000 households in the City of Cape Girardeau (SEMO, 1975), and according to a study by De Graaf and Payne (1975), about 2,200 (20 percent) participated in the feeding of wild birds. Using figures developed in this study, approximately $43,000 per year is spent on nature-related activities near home. This indicates a substantial interest; however, in many cases people may not be aware of measures they could take to improve their backyard wildlife habitat.

110. The following steps could be taken by the local sector to encourage the development of residential wildlife habitat:

a. Provide technical assistance and plantings to interested individuals and organizations. The Missouri Department of Conservation, that now has an urban wildlife biologist on its staff, could aid in this effort.

b. Establish wildlife demonstration areas on public lands such as parks. These areas could simulate typical backyards and show management practices which could be used. Sample "1 year old" backyards could be established at a cost of about $300 each. Every 10 years of project life, a new "1-year old" backyard could be planted. Each demonstration backyard would be maintained in a normal way, that is, by trimming shrubs and mowing lawns.

c. Wildlife management seminars could be conducted by wildlife professionals for interested individuals where backyard wildlife management techniques could be presented and literature could be distributed.

d. Utilize interested individuals to volunteer their backyards as showplaces for wildlife management practices. Members of the local conservation groups such as the Audubon Society may be interested in participating.

111. Wetlands Preservation. This measure would ensure that the local sector take action to preserve the 30 acre wetland complex located near the junction of Highways 61 and 74. The forested wetland area is of particular importance since it represents a relic natural area and a refuge for many species which do not exist elsewhere in the watershed. This measure would represent the most significant contribution towards addressing the wetlands preservation objective, while at the same time providing contributions to erosion control water quality and endangered species.

112. Riffle and Pooling Devices. Two possibilities exist for the placement of aquatic habitat structures within the reach between Independence and Hopper Roads. At RM 3.7 a wier, 2-feet high, would ensure water depth. At River Mile 4.2 a stone-fill structure would pool water to a minimum 2-foot depth and provide a downstream riffle. These structures would provide improvement in habitat diversity.

113. Fish Pond Improvements. This measure would enhance the habitat value of two existing farm ponds (totaling 1.2 acres) adjacent to the dry detention site. The present dams for these ponds would receive structural improvements as required. The ponds would be deepened, if found necessary, and there adjacent above water slopes planted to trees and shrubs. These improvements would increase the longevity of the ponds by reducing the effects of siltation and dam failure. This measure would represent a separable EQ cost.

114. Hillside Fish Pond. This measure would entail the construction of a small impoundment along one of the draws adjacent to the dry detention site. A seven acre pond would result. The measure would address the need for reducing aquatic habitat losses.

115. Support for Pollution Control. Community support for the programs of state and Federal agencies charged with the responsibility of protecting our nations waters could contribute significantly to the Water Quality Objective.

116. Litter/Debris Control. A litter/debris control program would be effective in solving the problem of trash being dumped in and along the creek. This measure would contribute to good water quality, which would in turn benefit aquatic organisms. This measure could improve aesthetic qualities as well as remove potential safety and health hazards. Anti-litter and no dumping ordinances, strict law enforcement and periodic clean-up programs by public, private or voluntary work crews would represent a vehicle for the implementation of this measure.

BIOLOGICAL MONETARY ANALYSES AND MITIGATION REQUIREMENTS

117. A detailed analysis of the biological monetary impacts associated with each project plan is in the St. Louis District's files. The following is a summary of the results of that study.

118. TABLE 12 gives a summary of the net change in dollars associated with each project plan by wildlife habitat type, relative to the future without a project. From this table it can be seen that the overall impact of all project plans on wildlife is a positive one; this results principally from the substitution of high nonconsumptive use park land for residential habitat. The only negative project impacts identified was to residential habitat; however, residential areas would probably not actually be eliminated, but merely displaced to some location outside of the specific project area. In summary, no wildlife mitigation is required for any of the project plans.

119. The Fish and Wildlife Coordination Act Report recognizes that aquatic mitigation is not required in either the NED or Recommended Plans.

TABLE F-12
SUMMARY OF WILDLIFE MONETARY
ANALYSIS FOR TOTAL PROJECT AREA (ANNUALIZED)

Habitat Type	Changes in Dollars			
	REC	NED	EQ	A
Bottomland	237.73	237.73	1,399.17	789.26
Open Land	471.99	471.99	1,529.08	929.09
Upland	4.02	4.02	575.98	428.21
Water	0.00	0.00	0.00	0.00
Residential	-479.06	-449.20	-944.33	-513.61
Other Development	0.00	0.00	0.00	0.00
TOTAL	234.68	264.54	2,559.90	1,632.95

U.S. FISH AND WILDLIFE REPORT

120. The U.S. Fish and Wildlife Service Coordination Act Report for the Cape Girardeau/Jackson Study is provided within VOLUME FOUR.

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RECREATION RESOURCES

EXISTING OUTDOOR RECREATION

121. The city of Cape Girardeau and the county have secured a substantial number of parks for their citizens. There are 570 acres of parks within the watershed. The county of Cape Girardeau maintains 250 acres and the city of Cape Girardeau has 320 acres. City parks outside of the watershed total 115 acres. The majority are in metro-county and district units. These parks are widely distributed to provide recreational opportunities within reasonable distances of the public.

122. The National Park Service (NPS) through the former Heritage Conservation and Recreation Services (HCRS) Mid-Continent Region, Denver, compiled a survey of recreation in the Cape Girardeau-Jackson area. HCRS also completed a "Level C," Major Leisure-Time Investigation on 1 June 1978, revised 1 April 1980, both of which are on file in the St. Louis District. These studies point out that numerous recreational facilities/opportunities are in short supply.

123. The Recreation Market Area (RMA) was established to include the Cape La Croix Creek watershed and the city of Cape Girardeau. TABLE A-11 displays the total recreation acres available in the city of Cape Girardeau city and county, and the owners of these acres.

FUTURE RECREATION WITHOUT PROJECT

124. The city of Cape Girardeau, as in the past, continues in providing outdoor recreational facilities. The various administrations that have been in office during the course of this study have indicated a strong commitment to maintain these efforts. However, no future plans for additional recreational open space are presently contemplated.

AD-A141 579 WATER RESOURCES INVESTIGATION CAPE GIRARDEAU - JACKSON METROPOLITAN AREA MISSOURI VOLUME 2 APPENDICES(U) ARMY ENGINEER DISTRICT ST LOUIS MO DEC 83 4/4

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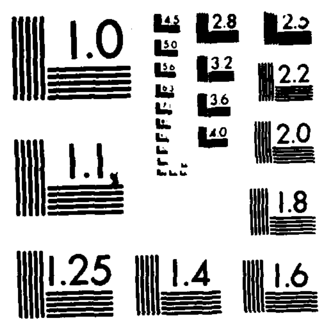

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

SUMMARY OF RECREATION FEATURES IN SHORT SUPPLY (2020)

125. Through the investigation of the (NPS), the following recreation activities in the basin will be in short supply by the year 2020: (1) Outdoor games and sports - 188 acres; (2) group camping - three acres; (3) open play areas - 222 acres; (4) football/soccer - 33 fields; (5) baseball/softball - nine fields; (6) basketball - seventeen courts; sixteen swimming pools; (8) tent camping - 84 sites; (9) stream fishing - 328 miles; (10) tennis - nine courts; (11) golf - three courses; (12) bike trails - 351 miles; (13) hiking trails - 43 miles; (14) horse trails - 99 miles; and (15) Picnicking - 539 tables. Representatives of the city of Cape Girardeau have stated that group camping facilities are overused and that additional units are needed.

126. These needs were related to land areas and recreational opportunities provided by the flood control project along Cape La Croix Creek. Included in the overall recreation considerations were the recreation opportunities of Detention Sites 1 and 2.

127. During coordination with the city's Parks and Recreation Department, the following recreation activities were selected for the final array of plans: (1) hiking and biking trails; (2) picnicking; (3) open play areas; (4) nature trails; (5) horse trails; (6) group camping; (7) exercise trail, and (8) frisbee disc courses.

128. With the above recreation uses, an opportunity existed to evaluate and design the recreational features of a final array of plans. In all of these plans attempts were made to maximize recreational opportunities, with the most viable quantity of acreages and miles available in the stream corridor.

RECREATION PLANS CONSIDERED

129. Recreation features were developed for the following plans: the NED Plan, Plan A, the Environmental Quality Plan and the Recommended Plan. TABLE F-13 displays the recreation features and benefits associated with each of these plans. TABLE F-14 provides a more detailed comparison of the recreation features of the NED Plan and the Recommended Plan.

130. NED Plan.

a. Detention Site. A total of 157.27 acres would be required for both flood control and recreation purposes. Eighty-five acres would be developed for recreation, including 61 acres within the area required for flood control. Of the additional 24 acres located outside the flowage easement boundary, 5.6 acres are required for access, sanitation, and potable water and would be cost shared 1/2 Federal and 1/2 non-Federal. Recreation features at the detention site would consist of the following (see PLATE F-5):

TABLE F-13
CAPE GIRARDEAU-JACKSON RECREATION BENEFITS AND FEATURES

Plan	Picnic	Open Play Areas	Nature Trails	Group Camping	Exercise Trail	Disc Course	Hiking	Biking	Horse Trail	Wild Life	Total Annual Benefits
A											
Rec. Units	43 Tables	6 Acres	0.5 mile	30 Units	2 mile	1	7.21 mi.	7.21 mi.	4.27 mi.		
Benefits	$54,180	$ 70,560	$3,740	$3,024	$12,096	$8,400	$50,344	$23,469	$6,060	$1,600	$233,473
EQ											
Rec. Units	68 Tables	10 Acres	1.8 mile	60 Units	2 mile	2	9.8 mi.	9.8 mi.	4.27 mi.		
Benefits	$85,680	$117,600	$13,465	$6,048	$12,096	$16,800	$68,428	$31,899	$6,060	$2,600	$360,676
Recommended											
Rec. Units	43 Tables	6 Acres	0.5 mile	30 Units	2 mile	1	7.21 mi.	7.21 mi.			
Benefits	$54,180	$70,560	$3,740	$3,024	$12,096	$8,400	$50,344	$23,469	$ 0	$ 300	$226,313
NED											
Rec. Units	33 Table	4 Acres	0.5 mile	30 Units	1 mile	1	7.21 mi.	7.21 mi.			
Benefits	$41,580	$47,040	$3,740	$3,024	$6,048	$8,400	$50,344	$23,469	0	$ 300	$183,945

Visitor Days are valued at $2.10 as per P & G

TABLE F-14
RECOMMENDED & NED PLANS COMPARISON OF RECREATION

Location	Plan	Hiking Trail	Bicycling Trail	Picnicking	Open Play Areas	Nature Trails	Group Camping	Exercise Trail	Disc Course	Total Visitor	Total Benefits	Total Annual Benefits
Stream Corridor	Rec.											
	Units	6.61 M	6.61 M								NED	Rec.
	Visitors	21,978	10,245							32,223		
	Benefits	$46,154 *	$21,515									$67,669
	NED											
	Units	6.61 M	6.61 M									
	Visitors	21,978	10,245							32,223		
	Benefits	$46,154	$21,515								$ 67,669	
Sprigg Street	Rec.											
	Units			5 Tables	2 Acres							
	Visitors			3,000	11,200					14,200		
	Benefits			$6,300	$23,520							$29,820
	NED											
	Units											
	Visitors											
	Benefits											
Bessie Street	Rec.											
	Units			3 Tables								
	Visitors			1,800						1,800		
	Benefits			$3,780								$ 3,780
	NED											
	Units			3 Tables								
	Visitors			1,800						1,800		
	Benefits			$3,780							$ 3,780	

TABLE F-14 (Cont'd)
RECOMMENDED & NED PLANS COMPARISON OF RECREATION

Location	Plan	Hiking Trail	Bicycling Trail	Picnicking	Open Play Areas	Nature Trails	Group Camping	Exercise Trail	Disc Course	Total Visitor	Total Benefits	Total Annual Benefits
Golliday Addition	Rec.											
	Units			10 Tables				1 Mile			NED	Rec.
	Visitors			6,000				2,880		8,880		
	Benefits			$12,600				$6,048				$ 18,648
	NED											
	Units			5 Tables								
	Visitors			3,000						3,000		
	Benefits			$6,300							$ 6,300	
Detention Site 1	Rec.											
	Units	0.6 M	0.6 M	25 Tables	4 Acres	0.5 Mi.	1 (30)	1 Mile	1			
	Visitors	1,995	930	15,000	22,400	1,780	1,440	2,880	4,000	49,706		
	Benefits	$4,190	$1,953	$31,500	$47,040	$3,740	$3,024	$6,048	$8,400			$105,812
	NED											
	Units	0.6 M	0.6 M	25 Tables	4 Acres	0.5 Mi.	1 (30)	1 Mile	1			
	Visitors	1,995	930	15,000	22,400	1,780	1,440	2,880	4,000	49,706		
	Benefits	$4,190	$1,953	$31,500	$47,040	$3,740	$3,024	$6,048	$8,400		$105,812	
											$183,648	$226,112

* Recreation Benefits are Valued at $2.10 as per P&G

This TABLE is the basis for TABLE G-17 variations in Total Values are accounted for by the rounding of numbers.

(1) 0.6 miles of hike/bike trails.

(2) 0.5 miles of nature trails.

(3) 1 mile of exercise trails.

(4) 4 acres of open play areas.

(5) A disc course.

(6) A group camping area for 30 people.

(7) 25 picnic tables.

(8) 3 parking areas (2 for 10 cars, 1 for 25 cars).

(9) 3 comfort stations.

b. Stream Corridor.

(1) Connecting Trail - A 3.3 mile hike/bike trail would be provided by non-Federal interests along Cape La Croix Creek from the upper end of the channel project to Highway W as a connecting link between downstream recreation features and recreation features at the detention site. An additional 0.5 mile trail would parallel the access road from Highway W to the detention dam. This segment of the trail would be cost shared 1/2 Federal and 1/2 non-Federal.

(2) A 7-foot wide hike/bike trail, 2.81 miles in length, would be located parallel to and within the rights-of-way required for channel improvements along Cape La Croix Creek and Walker Branch. This feature would be cost-shared 1/2 Federal and 1/2 non-Federal.

(3) Bessie Street Site - Eight mobile homes would be relocated because of channel improvements and the area converted to recreation use. Three picnic tables and a drinking fountain would be provided at 1/2 Federal and 1/2 non-Federal cost.

(4) Golliday Addition Site - Ten residences would be relocated because of channel improvements and the area converted to recreation use. Five picnic tables would be provided at 1/2 Federal and 1/2 non-Federal cost.

131. Plan A. In addition to the recreation features included in the NED Plan, Plan A provides for additional recreation opportunities on project lands. The additional recreation features follow (see PLATE F-7 and TABLE F-13):

a. Golliday Addition Site. Eighteen additional residences would be removed as a non-structural flood control feature and the area

converted to recreation use consisting of five additional picnic tables and an exercise trail.

b. Sprigg Street Site. Thirty-seven structures would be removed as a non-structural flood control feature and the area converted to recreation use consisting of five picnic tables, a two-acre open play area, a six-car parking area, a drinking fountain, and a fishing pier.

c. A horse trail connecting Arena Park and the detention site.

132. Environmental Quality Plan. All recreation features of the NED Plan Plan A are included in the EQ Plan. In addition, the EQ Plan contains the following (see PLATE F-8 and TABLE F-13):

a. A hike/bike trail from Bloomfield Road to Sprigg Street (2.59 miles).

b. Meander Site. Recreation facilities at this site would consist of ten picnic tables, two acres of open play area, 0.8 miles of nature trail, and a group camp.

c. Hopper Road Site. Recreation facilities at this site would consist of 15 picnic tables, two acres of open play area, 0.5 miles of nature trail, an exercise trail, and a disc course.

133. Recommended Plan. The recommended plan contains all recreation features of the NED Plan. In addition, the recommended plan includes the non-structural measure for relocation of 55 residences at the Golliday Addition and Sprigg Street areas with the areas converted to recreation use. At Sprigg Street, 37 structures would be removed and developed for recreation consisting of five picnic tables, a two-acre open play area, a six-car parking area, a drinking fountain, and a fishing pier. At the Golliday Addition, 18 additional structures would be removed and the area developed for recreation consisting of five additional picnic tables and a one-mile exercise trail (see PLATE F-6 and TABLE F-13 and F-14).

CAPE GIRARDEAU-JACKSON
METROPOLITAN AREA, MISSOURI

SURVEY REPORT

APPENDIX G

ECONOMICS

CAPE GIRARDEAU - JACKSON
APPENDIX G
ECONOMICS

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CAPE GIRARDEAU - JACKSON
APPENDIX G

ECONOMIC ANALYSIS

1. The purpose of this appendix is to present a summary of the detailed economic analysis accomplished for the Cape Girardeau-Jackson Study. This appendix covers the Cape La Croix and Walker Branch basins. The economic data presented are based on October 1983 price levels. Average annual computations are based on an 8-1/8 percent interest rate and a 100-year period of analysis.

FLOOD DAMAGE CALCULATION PROCEDURES

2. As a means of quantifying the magnitude of the flood problem within the Cape Girardeau/Jackson study area for the future without project conditions, selected hydrologic and hydraulic output from HEC-2 and HEC-1, respectively, were used in conjunction with basic economic information to estimate the dollar amount of flood damages expected to occur on an average annual basis. The basic procedures used to compute average annual damages involved: (1) locating all flood damageable property; (2) estimating their structural and content values and associated miscellaneous damages; (3) computing total damages; and, (4) computing average annual damages. Each of these steps is discussed in the following paragraphs.

LOCATING DAMAGEABLE PROPERTY

3. The process of determining average annual damages began with field surveys of all residential, commercial, and industrial properties within the standard project flood plain boundaries as defined by the hydraulic studies. Each structure was catalogued according to reach, first floor level elevation, type of structure, value of structure and closest upstream cross-section. The first floor elevations were determined through surveying. The field inventory that was performed in the Stage 2 studies was updated to reflect October 1983 price levels. In addition, new or removed structures were incorporated into the inventory for the Stage 3 studies based upon field inspection.

ESTIMATING DEPTH-DAMAGE VALUES

4. Damages to residential structures were computed by relating 1974 Federal Insurance Administration (FIA) depth-damage curves to the elevation of each structure within the Standard Project Flood (SPF) flood plain. (Structural types were defined for this study consistent with the classifications given in the 1974 FIA depth-damage tables. These classifications were used in lieu of simply the "with" or "without" basement classifications in order to more accurately determine the damage incurred by each type of structure.) A survey of local homeowner's insurance companies and the State of Missouri Office of Insurance

indicates the value of residential unit contents in the urban area is estimated to be 50 percent of the structural value. The resultant figures are then used, along with the damage percentages given in the FIA table, to compute content damage. (See Attachment 1 for table of depth percent damage data.) Contents include furniture, appliances, domestic goods, and fixtures. For this study, miscellaneous damages are computed to be 30 percent of the combined structural and content damage. Miscellaneous damages include clean-up costs, utilities, emergency health care, landscape damage, and public lands. Individually, the flood damages to each miscellaneous item are minimal in terms of structural and content damage. However, taken together, they represent a significant portion of the flood damages.

5. Miscellaneous damages of 30 percent were developed by constructing depth-damage and frequency-damage curves for urban areas. Two distinct miscellaneous categories were analyzed: (1) damages associated with households; and (2) damages associated with community infrastructure.

6. Household miscellaneous damages included the following items:

Personal papers	Temporary relocations	Clean-up
Vehicles	Fences	Building inspections
Storage sheds	Shrubs	Driveways
Traffic re-routing	Patios	Utility connections
Lost gasoline	Carport/garages	Demolition of structure
Re-seeding	Trees	
Erosion	Lawn mowers	

7. A sample of 100 structures in a typical urban setting were inventoried and analyzed for various elevations, typical landscaping, and distribution and location of damagable items, as well as typical unit values. Delayed damages were implicitly included such as cracking of driveways and patios, rusting of storage sheds, and dry-rotting of wooden structures.

8. Infrastructure miscellaneous damages are those associated with community integrity. They include the following:

Street lights	Streets	Parks/playgrounds
Water mains	School closings	Bridges
Water laterals	Telephone outlets	Police/fire/medical services
Gas mains	Sewers	National Guard activities
Gas laterals	Catch basins	Traffic re-routings
Closed services	Telephone poles	
Sidewalks	Street clean-up	

9. Typical neighborhood characteristics, i.e., number of telephone poles, width of streets, linear feet of sewers per square mile, et al., were examined. The means and magnitude of damages were evaluated using engineering judgment, actual data when available, and regional economic information. Delayed damages were also considered.

10. When household and infrastructure depth-damages were aggregated and tied to frequency, a sensitivity test was conducted for various structures. Three average annual miscellaneous damages estimates resulted: 29 percent, 39 percent, and 30 percent. The mean of these three estimates was 33 percent, and a 30 percent value was selected for use in the following damage estimates.

11. Items not included in the miscellaneous inventory but which will nonetheless experience damages include the following:

Stop lights	Lost drinking water	Bus service
Mail boxes (and contents)	Lost gas	Fire damages
	Lost wages	Lost taxes
Road signs	Park equipment	Cost of purchasing new home
Billboards	Electricity losses	

These items were not evaluated for various reasons, including variability in values, locational problems, and the lack of sufficient and/or adequate data.

12. Commercial/industrial values were estimated by using "Boeckh General Estimate Manual" (Boeckh Publications - A Division of the American Appraisal Company, Inc.) and on-site field surveys, which were finalized in January 1982.

13. Commercial damage estimates were developed for both structural damage and content damage. The structural damage components were developed from observations of damages to residences. Commercial establishments are constructed of the same materials, i.e., brick, wood, tile, electrical, and plumbing. Consequently, the "typical" commercial structure would be damaged in a manner similar to that of residences. The appropriate FIA residential structure code and damage curve was matched to each commercial structure of similar design and construction materials.

14. Content damage curves were developed from interviews with proprietors focusing on commercial groups, contents, location, and damagability of inventory. For example, eight gas station owners/managers were interviewed for structure value, square footage of floor space, equipment and inventory value, annual sales, etc. Similar field inventories were conducted for churches, shoe repair shops, quick food stores, grocery stores, drug stores and pharmacies, laundry, cleaners, etc.

FLOOD DAMAGE ANALYSIS AND EVALUATION

15. The tool used to evaluate future annual flood damages for various alternatives is the St. Louis District Corps of Engineers' Urban Damage II program.

16. In this study, the results of flood damage calculations are expressed in two forms:

a. Single event damages (i.e., damages resulting from a flood of known probability of occurrence such as the one-percent chance flood event which has a one percent chance of occurring in any given year, a 100-year flood).

b. Average annual damages (i.e., the amount of damage that can be expected yearly, based on the full range of flood events over a long period of time under a given set of physical conditions).

17. Single-event calculations are performed automatically by the Urban Damage II computer program. This program uses the frequency profiles for each cross-section from HEC-2W output Summary Table 150. The river miles at each section are computed from section numbers or from channel lengths. The elevations of the profiles at the structure are then interpolated from the profiles at the up- and downstream sections, using the river mile of the structure and the river mile of the up- and downstream sections. For this study, damages from the 50-, 20-, 10-, 2-, 1-, and .02- percent chance events are computed. These flood events are more commonly known as the 2-, 5-, 10-, 50-, 100- and 500-year flood events, respectively.

18. Average annual damages are also computed by the Urban Damage II program. These damages represent the average yearly damage for a particular set of hydrologic, hydraulic, and damage conditions. When a calculated average annual damage value is desired, the damage corresponding to each depth of flooding is weighted by the probability of that depth occurring. These weighted damage values are calculated for the full range of events and represent the average annual flood damages.

FUTURE WITHOUT FLOOD DAMAGES

19. Under the future without project conditions, the occurrence of a 100-year flood event would cause inundation damages to 246 residential units and 176 commercial/industrial structures. Total damages for the 100-year flood and the Standard Project Flood would be $22,093,500 and $44,008,800, respectively. Average annual damages are $4,126,100. TABLE G-1 shows the breakdown of the total damages by reach and event for residential units. TABLE G-2 shows the identical breakdown for commercial units. Total damages by reach and event for all units, commercial and residential are displayed in TABLE G-3 and average annual damages are displayed by reach in TABLE G-4.

20. Basin-wide damages for the 1973, 1977, and 1981 floods are not available. Newspaper reports and field interviews reveal that these floods caused considerable damages. High water marks are still visible on many structures. These photos and newspaper accounts are available in the St. Louis District office.

TABLE G-1
CAPE GIRARDEAU - JACKSON
TOTAL RESIDENTIAL INUNDATION DAMAGES
STANDARD PROJECT FLOOD PLAIN
FUTURE WITHOUT CONDITIONS
October 1983 (Dollars)

Creek	Reach Mile	2-Yr.	5-Yr.	10-Yr.	50-Yr.	100-Yr.	500-Yr.	SPF
Cape La Croix	0.33-2.76	-	5,600	46,500	75,600	94,500	105,900	196,900
	2.76-3.76	-	-	-	-	1,700	12,200	21,800
	3.76-5.11	8,400	19,200	39,200	393,600	662,600	1,024,500	2,227,300
	5.11-8.45	-	-	-	3,900	5,900	14,600	41,800
		8,400	24,800	85,700	473,100	764,700	1,157,200	2,537,800
Walker	0.00-0.40	13,000	83,800	112,900	181,200	208,500	229,300	295,100
	0.40-0.89	33,100	55,300	147,500	215,500	302,900	443,300	950,100
	0.89-1.10	116,100	189,600	205,400	222,500	240,900	243,200	271,000
	1.10-1.71	136,300	243,400	422,400	707,000	795,000	868,000	877,000
	1.71-2.00	2,400	30,600	64,100	99,600	109,200	116,000	117,500
		300,900	602,700	952,300	1,425,800	1,666,500	1,899,800	2,510,700
	TOTAL	309,300	627,500	1,038,000	1,898,900	2,421,200	3,057,000	5,048,500

TABLE G-2
CAPE GIRARDEAU - JACKSON
TOTAL COMMERCIAL INUNDATION DAMAGES
STANDARD PROJECT FLOOD PLAIN
FUTURE WITHOUT CONDITIONS
October 1983 (Dollars)

Creek	Reach Mile	2-Yr.	5-Yr.	10-Yr.	50-Yr.	100-Yr.	500-Yr.	SPF
Cape La Croix	0.33-2.76	-	-	7,700	32,900	44,300	505,500	2,215,700
	2.76-3.76	-	151,200	630,400	2,355,500	3,432,300	5,215,700	12,452,100
	3.76-5.11	330,000	863,300	2,018,100	3,144,500	3,455,200	3,941,900	5,287,400
	5.11-8.45	-	26,900	56,600	737,300	881,000	1,244,000	1,676,300
		330,000	1,157,100	2,712,800	6,270,200	7,812,800	10,913,100	21,631,500
Walker	0.00-0.40	127,200	470,800	2,321,600	5,423,500	7,017,900	8,173,800	10,739,500
	0.40-0.89	1,571,400	2,974,000	3,612,600	4,210,900	4,362,300	5,170,400	6,260,600
	0.89-1.10	23,500	169,600	259,100	259,500	278,700	296,200	328,700
	1.10-1.71	-	-	-	-	-	-	-
	1.71-2.00	-	-	-	-	-	-	-
		1,722,100	3,614,400	6,193,300	9,893,900	11,858,900	13,640,400	17,328,800
	TOTAL	2,052,100	4,771,500	8,906,100	16,164,100	19,671,700	24,553,500	38,960,300

TABLE G-3
TOTAL INUNDATION DAMAGES
STANDARD PROJECT FLOOD PLAIN
FUTURE WITHOUT CONDITIONS
October 1983 (Dollars)

Creek	Reach Mile	2-Yr.	5-Yr.	10-Yr.	50-Yr.	100-Yr.	500-Yr.	SPF
Cape La Croix	0.33-2.76	-	5,600	54,200	108,500	138,800	611,400	2,412,600
	2.76-3.76	-	151,200	636,400	2,355,500	3,434,000	5,227,900	12,473,900
	3.76-5.11	338,400	998,200	2,057,300	3,538,100	4,117,800	4,966,400	7,564,700
	5.11-8.45	-	26,900	56,600	741,200	887,500	1,258,600	1,718,100
		338,400	1,181,900	2,804,500	6,743,300	8,578,100	12,064,300	24,169,300
Walker	0.00-0.40	140,200	554,600	2,434,500	5,604,700	7,226,400	8,403,100	11,034,600
	0.40-0.89	1,604,500	3,029,300	3,760,100	4,426,400	4,865,200	5,613,700	7,210,700
	0.89-1.10	139,600	359,200	464,500	482,000	519,600	539,400	599,700
	1.10-1.71	136,300	243,400	422,400	707,000	795,000	868,000	877,000
	1.71-2.00	2,400	30,600	64,100	99,600	109,200	116,000	117,500
		2,023,000	4,217,100	7,145,600	11,319,700	13,515,400	15,540,200	19,839,500
	TOTAL	2,361,400	5,399,000	9,950,100	18,063,000	22,093,500	27,604,500	44,008,800

TABLE G-4
CAPE GIRARDEAU - JACKSON
AVERAGE ANNUAL DAMAGES (1)

STANDARD PROJECT FLOOD PLAIN
FUTURE WITHOUT CONDITIONS
Commercial and Residential Structures
(Price Level - October 1983)

Creek	Reach Mile		Average Annual Damages	Damages Per Unit
Walker	0.00-0.40		$ 751,800	6,200
	0.40-0.89		1,843,900	13,900
	0.89-1.10		198,700	3,600
	1.10-1.71		258,300	1,700
	1.71-2.00		33,300	1,600
		TOTAL	$3,086,000	$ 6,500
Cape La Croix	0.33-2.76		$ 14,400	100
	2.76-3.76		218,100	4,200
	3.76-5.11		754,300	5,200
	5.11-8.45		53,300	700
		TOTAL	$1,040,100	$ 2,800
			$4,126,100	$ 4,900

FOOTNOTE:
(1) Note that SPF damages have not been included in average annual figures. Average annual SPF damages have been approximated to be less than one-half percent of the total average annual figure reported. Given a known probability of occurrence an exact figure could be calculated.

BENEFITS ANALYSIS

21. The primary economic benefit that would accrue to the selected plans would be reduction of urban flood damages.

FLOOD HAZARD REDUCTION BENEFITS

22. Average annual damage reduction benefits are equal to the difference in average annual flood damages that would be expected without the proposed improvements and residual average annual damages that would be expected to occur with the proposed improvements.

23. Flood damage reduction benefits for the final array of plans are estimated by evaluating damages with and without the project under future conditions. Future conditions take into consideration changes that were expected to take place on the flood plain in the study area over the life of the proposed plan. (See paragraph 33 for further discussion of expected future conditions.)

24. Average annual damages are computed using the Urban Damage II Program previously discussed in this Appendix, for both conditions "with" and conditions "without" the project plans. The difference between the average annual damages under "with" conditions and "without" conditions represents the average annual flood damage reduction benefit which is attributable to the proposed project.

25. A field survey of high damage areas (reaches) was conducted in order to test the validity of the flood control simulation effort. Several observations were made regarding the outcome of the field check.

26. The data showed that overall damages were what would be expected if an actual rather than simulated flood event were to occur. Specific instances of higher and lower than expected damages were observed. This was especially true of commercial structures. Specific checks revealed that the cause of deviations come from a variety of sources.

27. Some owners of commercial structures who had experienced flooding from the 1973 and 1977 floods have taken steps to flood proof their building and inventories. These measures included installing waterproof walls, closure structures around doors and windows, placing inventory on pallets, and otherwise raising damagable items above floor or previous flood levels. These measures do not necessarily invalidate modeled results when comparing simulated with actual damages. For example, a structure flood-proofed to keep water out is subject to hydraulic forces that may cause walls to collapse, thereby creating greater damages. In addition, how long such measures will continue to be utilized is unknown.

28. Another source of flood protection is a readily available store of on site sandbags, the effect of which is uncertain in terms of damage reduction. The number of sandbags needed varies from flood to flood.

Many owners base their quantity of stored sandbags on previous floods, not accounting for possible higher floods with future events. The ability to respond when rapid peaking occurs is an added uncertainty. It is doubtful that sufficient manpower can be obtained in time for sandbagging to be effective during flash floods typical of most flood events in this region.

29. Another factor contributing to the difference between actual flood damages and modeled conditions is the sensitivity of a structure's river mile location. It was noted that in some instances the placement of a structure one hundredth of a mile either up or downstream from its tested location changes damages considerably. This degree of accuracy is beyond the precision of other data, i.e., flood elevations, mapping contours, and FIA damage curves, and thus not appropriate here.

30. Two additional and interrelated factors accounting for differences between modeled and actual damages are structural complexities and actual water entry points. Multiple first floor elevations in the same structure are not accounted for in FIA damage curves. For example, an office was observed at one elevation, the inventory and delivery dock were at a second level, and processing at a third level.

31. Water entry points are often deceiving. Flood flows do not necessarily enter at the lowest point. For example, flood flows may cross overland and enter through a front entrance first even though the rear of the building is at a lower elevation or vice versa.

32. The sum and substance of these field observations and comparisons with simulated flooding leads to the conclusion that instances of higher and lower than expected damages are occurring in modeled results. Selected tests were conducted to account for river mile location, flood entry points, and some flood proofing. The tests revealed significant damages increases and decreases to specific structures, but given the variability of possible circumstances as previously outlined, it is not clear that the results are any more or less valid. The benefits and damages reported are believed to be a reasonable approximation of overall plan performance with variances cancelling one another. None of the tests indicated that the benefit-to-cost ratio fell significantly.

FUTURE BENEFITS

33. Changes in future benefits compared to existing benefits are based entirely on increased damages to residential contents over the project life. This is expected to occur due to projected increases in personal disposable income. The OBERS regional growth rate for per capita income was used as the basis to increase the real value of residential contents in the future to account for this "affluence factor." The value of the residential contents was projected at the per capita income growth rate to a maximum level of 75 percent of the value of the residential structure. The projected increase is limited to the first 50 years of

the project life and is held constant after that point. Based upon results of this evaluation, the affluence effect is expected to increase total average annual damages very slightly. It should be noted that damages to residential structures represent only eleven percent of total damages, which in turn accounts for the small increase in benefits attributable to the affluence factor.

34. Benefits from Enhancement of Property Values. Location and intensification benefits attributable to a project are the direct primary benefits from increased use of land through either intensified activities or by changing to an economically higher state of development than would occur in the absence of the project. Such benefits result because of the higher utilization made feasible by increased safety of investments in improvements. Location benefits are evaluated only for lands which have a reasonable prospect of change in usage, whereas intensification benefits are evaluated only for lands which have a reasonable prospect of remaining in the same land use but intensifying in activity. Each of these categories of benefits is discussed below.

a. Location Benefit. It can be observed that a large quantity of undeveloped land within the study area exists outside the bounds of the 100-year flood plain. Since the flood plain along Cape La Croix Creek and Walker Branch offers no location advantage over numerous alternative sites in Cape Girardeau, whether the flood prone area is protected or not, the availability of developable land in the immediate area would preclude claiming a location benefit for any of the alternative plans.

b. Intensification Benefit. Intensification benefits occur when an activity on the flood plain modifies its operation because a reduction in potential flood damage makes it profitable to do so. Given the retail-commercial character of the high damage reaches on the Cape La Croix Creek and Walker Branch flood plain, any increase in project benefits due to intensification would be very slight and, therefore, is not included in this analysis.

35. Redevelopment. There are no redevelopment (employment) benefits applicable to the Cape Girardeau-Jackson study area. Neither Cape Girardeau County nor the city of Cape Girardeau qualify for the designation of "substantial and persistent" unemployment areas based on the criteria established by EDA in designating qualified areas under subsection 1 of Title IV of the Public Works and Economic Development Act of 1965 (Public Law 89-136, as amended).

EVALUATION OF NONSTRUCTURAL BENEFITS

36. The benefit from relocation and evacuation plans, such as the nonstructural components included in the final array of plans, is the net income earned by activities occupying the flood plain with the project plus that portion of the flood damages reduced by the project which are

not borne by the without-project flood plain occupants. Reduction of flood damages projected to be borne by without-project flood plain occupants are not counted as project benefits because the portion of these costs actually borne by flood plain activities themselves are reflected in the market value of the flood plain lands. Benefit evaluation for the nonstructural components, therefore, includes the following benefit categories:

a. Net income. The net income (earned) with the project may be estimated directly based on an analysis of a specific land use with the project. Recreation benefits are therefore included for that portion of the land that would be developed for recreation.

b. Externalized costs. Without-project land uses result in flood damages and other costs associated with the occupation of the flood plain by activities which are incompatible with the flood hazard. The portion of these costs actually borne by flood plain activities themselves are reflected in the market value of the flood plain lands. The other part of the costs is external to the activities in the flood plain and are typically borne by taxpayers or firms providing services to flood plain activities. Examples of such costs are subsidized flood insurance and flood emergency costs. Reduction of externalized costs of flood plain occupancy, that is, reduction of costs not borne by the flood plain activities, can be a major project benefit in favor of flood plain evacuation.

(1) Insurance Subsidies. One category of external costs associated with flood plain occupancy that can be avoided by a removal plan is public compensation for private flood damages through the subsidized Federal Flood Insurance Program. Savings in these external costs as project benefits is appropriate for properties in communities which participate in the Federal Flood Insurance Program or are expected to participate in the without-project condition. The projection of insurable flood damages for this study is based upon traditional depth-damage-frequency relationships used in projecting total flood damages. The projected total damages are reduced by subtracting: (1) losses which are non-insurable because they exceed the coverage limits of the subsidized program; (2) the deductible portion of each expected flood damage event; and (3) the annual cost of the insurance premium paid by the policyholders. For this benefit calculation, it has been assumed that all eligible parties purchase subsidized insurance. This assumption is made because the market value of properties which determine project costs reflect the availability of the program, not the extent of its utilization by current flood plain occupants.

(2) Flood Insurance Administration Costs. A national cost of the flood insurance program is the cost of its administration. A benefit equal to the cost for servicing policies has been claimed which is based upon the average cost per policy including agent commission and claims adjusting costs. These costs were obtained from FIA which were based on

data received from the Office of Insurance Operation for the period of 1 January 1978 to 30 September 1979. This is the latest data presently available.

(3) Other Externalized Costs. Other public or otherwise externalized costs associated with use of the flood plain costs which can be avoided by evacuation or relocation of these flood plain activities are project benefits. Examples of such costs are emergency evacuation costs and flood fighting costs. Whenever these costs are not specifically charged to flood plain occupants, they are a proper NED benefit of plans which remove activities from flood plains.

ALTERNATIVES FOR ADDRESSING FLOOD CONTROL

37. It was apparent from the information generated to this point that a significant flood damage reduction potential existed in the Cape La Croix - Walker Branch watershed and that structural measures would very likely provide the primary means to realize this potential. In Stage 2, three basic measures that would address the flood control planning objective were identified in Plans 13, 14, 15, and 16, which were carried forward to Stage 3. The three measures were detention reservoirs, channel modifications/bridge removals, and flood proofing/relocation. Initial work in Stage 3 focused on examining the independent performance characteristics of each screened management measure on a first added basis. During this analysis, extensive flood proofing/relocation was screened out as a system-wide alternative for reasons discussed later in this section. The three basic measures for addressing the flood control objectives are summarized in the paragraphs that follow.

DETENTION RESERVOIRS

38. TABLE G-5 summarizes the results of the detention reservoir site analysis as discussed in APPENDIX B. Sites 1a, 3, 4, 5, 7, and 8 were eliminated for reasons stated. The performance of the remaining detention sites was quantified by computing the average annual benefit at each site generated as a "first-added" system component using the Urban Damage II program. Reservoirs capable of storing 10, 2, 1, and .02 percent chance storms were evaluated. The costs for the larger reservoirs increased far more rapidly than the benefits, which increased only slightly with the additional storage capacity. Therefore, the detention reservoir designed to store the storm with a 10-percent chance of occurrence was carried forward for further evaluation. TABLE G-6 compares the average annual benefits and estimated average annual costs for each site tested. As can be seen from the results, sites 1 and 2 generate benefit-to-cost ratios above unity from this first added test. These sites were, therefore, identified as prime candidates for inclusion in the flood control system plan formulation.

CHANNEL IMPROVEMENTS

39. During Stage III initial screening, emphasis was placed on refining the Stage II channel plan alternatives to produce the most effective configuration to address the flood control planning objective. A range of three system sizes was studied to obtain the expected optimum size:

a. Small - A channel approximately equal to the existing channel widths.

b. Large - The maximum widths practicable without necessitating extensive relocations.

TABLE G-5
DETENTION RESERVOIR SITE ANALYSIS

Site No.	Location (1)	Disposition
1	Cape La Croix Creek tributary about three miles upstream of Hopper Road	Carried forward from Stage 2 - See TABLE G-6 for Benefit/Cost Analysis.
1a	Cape La Croix Creek just upstream of Highway 61-34, near the northern city limits of Cape Girardeau	Eliminated due to high costs of fill required and relocating Route W.
2	Stream mile 8.84 on the main stem of Cape La Croix Creek	Potentially viable alternative. See TABLE G-6 for Benefit/Cost Analysis.
3	Unnamed tributary just upstream of the intersection of Highway 61-34 and Route W	Eliminated - Reduced peak flows from Subarea 7, but delayed peak discharge for a time period long enough to add more flow to the peak hydrograph of Cape La Croix.
4 & 5	Upper reaches of Walker Branch	Eliminated - Ineffective in reducing peak flows in the high damage reaches of Walker Branch. Additionally, present development in the vicinity of the two sites rendered costs prohibitive.
6	Mainstem of Cape La Croix Creek, upstream of Site 2	Potentially viable alternative - see TABLE G-6 for Benefit/Cost Analysis.
7	Mainstem of Cape La Croix Creek, just upstream of Hopper Road	Eliminated due to the costs involved in raising Mt. Auburn Road and Highway 61-34, and in protecting several homes and commercial structures that would be periodically inundated as a result of the reservoir.
8	Cape La Croix Creek, immediately upstream of Route W	Eliminated due to the costs involved in raising or protecting Route W, relocating several homes and commercial structures that would be periodically inundated as a result of the reservoir.

FOOTNOTE:
(1) See APPENDIX D for exact location.

TABLE G-6
CAPE GIRARDEAU - JACKSON
DETENTION BASIN PERFORMANCE ANALYSIS
October 1983 Dollars
8-1/8% Interest

Site	Average Annual Benefits	Average Annual Costs	Benefit-to-Cost Ratio
1	$751,000	$350,000	2.1
2	638,300	494,600	1.3
6	326,600	424,200	0.8

c. Medium - A channel size approximately halfway between small and large.

40. Selection of these varying sizes of channel plans to cover the probable range of practicable alternative schemes was based on existing stream and flood plain conditions, hydrologic characteristics of the upstream drainage area, topographic configuration, proximity of existing development to the stream, location of damage susceptible development and professional judgment of the study team. A more detailed description of the channel size selection process can be found in APPENDIX D.

41. The benefits and costs of the above channel sizes and various combinations of channel sizes on both Cape La Croix and Walker Branch are summarized in the NED ANALYSIS section below. The channel reaches displayed are damage centers; and, because of the continuity of flood flows, volumes, and hydrograph timing, are not to be considered an increment as such to a flood control improvement.

42. It should be noted at this point that Cape La Croix and Walker Branch flow parallel through a commercial district which has developed on their common flood plain. Severe flooding on one creek impacts flooding on the other in this district. Property damages from past floods have been severe and can be expected to recur in the future. Also, due to the depth of flooding and velocity of flow from either of the creeks, the potential exists for loss of life. Because a potentially catastrophic condition would remain if only one creek was improved, the channel improvements on Cape La Croix Creek and Walker Branch are considered to be a system.

FLOOD PROOFING

43. Studies on the cost to install various flood proofing devices to reduce economic losses and social disruptions due to flooding along Cape La Croix and Walker Branch were reviewed during the initial preparation of alternatives. Available data regarding the economic efficiency of flood proofing versus alternative flood protective measures (i.e., detention and channel improvements) indicated that flood control measures other than flood proofing were generally more economically efficient. Additionally, the actual installation of flood proofing measures would be somewhat uncertain due to the essentially voluntary compliance of the homeowner and commercial/industrial property owner. In addition, long term effectiveness of flood proofing measures would be dependent on a rather complicated and uncertain continued maintenance by many varied property owners. Temporary flood proofing, emergency doors and temporary window well covers would require the assumption that man-power was quickly available to install the temporary measures on very short notice. Some of the more significant reasons why flood proofing as an independent area-wide solution is dropped from further consideration include: (1) considerations of local property owner's financial capability to participate (assuming first their desire to participate);

(2) the complicated difficulties of insuring long term compliance; (3) the need to legally and appropriately modify building code requirements; (4) insurance requirements; and (5) significant potential safety problems.

RELOCATION

44. It was determined in the Stage 2 study process that relocation as an independent area-wide solution was not economically feasible. However, the acquisition and removal of structures was found to be a practical solution in some parts of the study area. In these cases, it was incorporated into the final array of project plans.

DEVELOPMENT OF DETAILED PLANS

45. Stage 3 emphasis was placed on modifying alternative plans carried forward from Stage 2 in an attempt to find the most effective configuration to reduce the effects of flooding from Cape La Croix Creek and Walker Branch. Intermediate flood control alternatives were developed using either one or a combination of the applicable water resources management measures discussed in the previous section. Concurrently, other features were being analyzed which would address the water and related land resources needs which were adopted as planning objectives to be utilized in the conduct of this study. A detailed description of the process of formulating the intermediate flood control alternatives can be found in APPENDIX B.

46. All flood control plans with positive net benefits are carried forward for further consideration, resulting in an array of 12 NED candidate alternatives. The 12 NED flood control alternatives are designated numerically in this Appendix for both discussion and display purposes, and are displayed in TABLE G-8 which presents pertinent benefit and cost data for each alternative, and shows the percent of total average annual damages which would be prevented by each of the alternatives. Economic data for all options are based on a 100-year period of analysis at 8-1/8 percent interest. Dollar figures reflect October 1983 price levels. It should be noted that at this stage in the formulation process, only damage reduction benefits are evaluated.

NED ANALYSIS

47. The search for the designated NED alternative involves finding the plan which maximizes net tangible benefits. Net economic benefits are maximized when plan scale is optimized, and the plan is economically efficient. Scale is optimized when the economic benefits of the last realistic increment of economic output for each practical measure in the plan equals the economic costs of the increment. A plan is economically efficient when the outputs of the plan are achieved in the least costly manner.

48. The data in TABLE G-7 indicate that Plan 11 maximizes net economic flood control benefits. It is therefore designated as the NED flood control plan. A description of the plan may be found in TABLE G-9 below.

49. The data in TABLE G-8 in conjunction with that in Table G-9 demonstrate the reasons for selecting Plan 11 as the NED flood control plan. All plans examined include the detention reservoir as the first added increment.

50. Plans 2, 4, and 8 explore the option of providing successively larger channel sizes along Walker Branch in conjunction with the detention reservoir upstream on Cape La Croix Creek. These channels each require a small transition section on Cape La Croix Creek near the confluence to insure structural integrity of the channels, as well as improvements downstream of the confluence to accomodate the larger water flows created on Cape La Croix Creek downstream of the confluence. As TABLE G-9 shows the net average annual benefits for Plans 2, 4, and 8 are $81,000, $1,382,000, and $699,000, respectively. The data indicates that in conjunction with the detention reservoir alone that the medium channel size on Walker Branch yields the greatest net average annual damages. Wherever possible, earth (grass-lined) or rip-rap channel segments are used as a result of their extreme low-cost in relation to concrete lined channels. However, in heavily urbanized segments, concrete channels must be used to generate the desired carrying capacity in the available space.

51. Plans 3 and 5 explore the option of providing successively larger concrete channel sizes along Cape La Croix in conjunction with the detention reservoir. A small transition section is required on Walker Branch to insure structural integrity of the channels. As the data in TABLE G-8 indicates, the average annual net benefits are $181,000 and -$74,000, respectively. This is a decrease from the level of the detention reservoir alone and hence, without some improvements on Walker Branch, the options of concrete channels on Cape La Croix Creek need no further pursuit.

52. The remaining plans are designed to explore the options of differing channel constructions and carrying capacities on <u>both</u> streams to see if net flood control average annual benefits can be further improved upon those of Plan 4. Plan 7 examines the smaller concrete channel on Cape La Croix Creek with the "medium" channel on Walker Branch, and Plan 9 examines the larger concrete channel on Cape La Croix with the medium channel on Walker. Both plans decrease the net average annual flood control benefits from the level of Plan 4 and consequently cannot be the flood control NED plan.

53. Plan 6 is a "scaled down" version of Plan 7, deleting improvements on the upper reach of Cape La Croix Creek (mile 3.80 - 5.11), a low damage center. However, the increase in net benefits from Plan 7 does not approach the level of Plan 4 and Plan 6 cannot be the flood control NED plan.

TABLE G-7
NED FLOOD CONTROL COSTS/BENEFITS
(OCT 83 PRICES, 8-1/8%, $1,000)

PLAN	AVERAGE ANNUAL COSTS (1)	AVERAGE ANNUAL BENEFITS	FLOOD CONTROL NET BENEFITS
1	350	851	501
2	1,517	1,598	81
3	1,609	1,790	181
4	2,019	3,401	1,382
5	1,892	1,818	(-74)
6	2,572	3,550	978
7	2,805	3,723	918
8	2,946	3,645	699
9	3,240	3,748	508
10	2,032	3,442	1,410
11	2,007	3,451	1,444 (2)
12	1,877	3,308	1,431

FOOTNOTES:

(1) Includes cost of bridge replacements, O&M, real estate, and replacements.

(2) Plan 11 maximizes net tangible economic flood control benefits.

TABLE G-8
FLOOD CONTROL
ECONOMIC PERFORMANCE OF FINAL NED CANDIDATES
(Price Level - October 1983)
8-1/8% Interest
($1,000)

	1	2	3	4	5	6	7	8	9	10	11	12
Annual Costs												
First Costs	313	1348	1498	1779	1759	2256	2467	2434	2873	1748	1685	1629
Real Estate	20	105	42	198	52	201	212	376	225	194	217	163
O&M	15	24	23	40	23	44	55	64	61	41	57	37
Replacement												
Channels @ 25 years	-	38	44	49	54	67	67	64	77	46	44	44
Bridges @ 50 years	-	-	-	2	2	2	2	6	2	2	2	2
Detention Reservoirs @ 50 years	2	2	2	2	2	2	2	2	2	2	2	2
TOTAL	350	1517	1609	2070	1892	2572	2805	2946	3240	2033	2007	1877
Annual Benefits	851	1598	1790	3401	1818	3550	3723	3645	3748	3442	3451	3308
Net Benefits	501	81	181	1331	-74	978	918	699	508	1409	1444	1431
Benefit-to-Cost Ratio	1.70	1.05	1.11	1.64	.96	1.38	1.33	1.24	1.16	1.69	1.72	1.76
Percent Damage Reduction	21	39	43	82	44	86	90	88	91	83	84	80

TABLE G-9
DESCRIPTION OF NED CANDIDATE PLANS
Flood Control

- Plan Number -

Stream	River Mile	1	2	3	4	5	6	7	8	9	10	11	12
Cape LA CROIX CREEK	2.72 - 2.76	-	TRANS-CON	TRAN-CON	TRAN-CON	TRAN-CON	TRAN-CON	TRAN-CON	TRAN-CON	TRAN-CON	TRAN-CON	TRAN-CON	TRAN-CON
	2.76 - 3.14	-	75'U-CON	75'U-CON	75'U-CON	100'U-CON	75'U-CON	75'U-CON	100'U-CON	100'U-CON	75'U-CON	75'U-CON	75'U-CON
	3.14 - 3.30	-	TRAN-CON	75'U-CON	TRAN-CON	100'U-CON	75'U-CON	75"U-CON	TRAN-CON	100'U-CON	TRAN-CON	TRAN-CON	TRAN-CON
	3.23 - 3.30	-	TRAN-CON	75'U-CON	TRAN-CON	100'U-CON	75'U-CON	75'U-CON	-	100'U-CON	RR	RR	RR
	3.30 - 3.76	-	-	75'U-CON	-	100'U-CON	75'U-CON	75'U-CON	-	100'U-CON	RR	RR	RR
	3.76 - 3.80	-	-	TRAN-CON	-	TRAN-CON	TRAN-CON	TRAN-CON	-	TRAN-CON	TRAN-RR	TRAN-RR	TRAN-RR
	3.80 - 6.11	-	-	-	-	-	-	110'-EARTH	-	100'-EARTH	-	-	-
WALKER BRANCH	0 - 0.40	-	30'-CON	TRAN-CON 2/	60'U-CON	TRAN-CON 2/	60'U-CON	60'U-CON	100'U-CON	60'U-CON	60'U-CON	60'U-CON	60'U-CON
	0.40 - 0.89	-	25'-CON	-	50'U-CON	-	50'U-CON	50'U-CON	100'U-CON	50'U-CON	50'U-CON	50'U-CON	50'U-CON
	0.89 - 0.96	-	TRAN-CON	-	TRAN-CON	-	TRAN-CON	TRAN-CON	TRAN-CON	TRAN-CON	TRAN-CON	TRAN-CON	TRAN-CON
	0.96 - 1.10	-	SMALL-EARTH	-	75'-EARTH	-	75'-EARTH	75'-EARTH	150'-EARTH	75'-EARTH	MED-CON	75'-EARTH	-
	1.10 - 1.68	-	25'-EARTH	-	75'-EARTH	-	75'-EARTH	75'-EARTH	150'-EARTH	75'-EARTH	75'-EARTH	75'-EARTH	-
	1.68 - 1.74	-	25'-EARTH	-	TRAN-RR	-	TRAN-RR	TRAN-RR	TRAN-RR	TRAN-RR	TRAN-RR	TRAN-RR	-
	1.74 - 2.00	-	-	-	35'-EARTH	-	35'-EARTH	35'-EARTH	35'-EARTH	35'-EARTH	35'-EARTH	35'-EARTH	-
DETENTION RESERVOIR		X 3/	X	X	X	X	X	X	X	X	X	X	X

1/ CON-denotes concrete channel, RR-denotes rip-rap lined channel, EARTH-denotes grass lined channel, TRAN-denotes a transition channel.

2/ extends to river mile 0.08.

3/ included in all plans.

54. Plan 11 explores the option of using a lower cost construction technique along Cape La Croix Creek in conjunction with the "medium" sized channel on Walker Branch. In this plan, the carrying capacity of Cape La Croix Creek is increased to a level somewhat lesser than the level of the smaller concrete-lined channel, but rip-rap is used to line the improved channel instead of concrete. This is a substantially lower cost technique, but requires a wider channel and consequently potentially greater real estate costs. However, in this case, the Plan 11 has greater net benefits than Plan 4 and is a candidate to be the NED flood control plan.

55. Plans 10 and 12 are further refinements of Plan 11. Plan 10 examines using concrete as an alternative to an earth channel in reach 0.96 - 1.10 on Walker Branch. This is to examine the feasibility of shrinking the space demands of the improvements through this reach. Plan 10 can be seen to decrease the net average annual benefits from the level of Plan 11.

56. Plan 12 examines the feasibility of providing improvements along the section of Walker Branch from mile 0.96 - 2.00. This is a relatively low damage center along this branch. However, Plan 12 shows a decrease in net benefits from Plan 11 and hence, the earth channel improvement is justified in this reach.

57. Hence, Plan 11 is the flood control NED plan. That is, any major alteration from Plan 11 decreases net average annual flood damage reduction benefits.

58. The search for a plan which maximizes net economic benefits thus far has focused on flood control. This is done to confirm that flood control can stand on its own in terms of tangible benefits and costs. A true optimal plan must include all benefits and all costs. To accomplish this, the data is refined to reflect greater detail. The following paragraphs complete the analysis and identify the final optimum plan.

RECREATION/ENVIRONMENT

59. In addition to flood control benefits and costs, the final 12 NED candidates contain associated recreation and environmental benefits and costs. The following basic information is used to evaluate recreation and environmental benefits.

60. The activity day-use and benefit values are evaluated per local applicability. Outdoor recreation activity is valued per visitation at $2.10 for all activities. The values assigned to fish and wildlife use are numerous and variable based on the specific habitat type involved. (See APPENDIX F for the specific values).

61. Only those recreation/environmental features which produce positive net economic benefits are incorporated into the NED candidate plans. TABLE G-10 displays the results of the recreation-environmental benefit analysis.

SUMMARY

62. TABLE G-11 provides refined information for all benefits and costs for each NED candidate. This table shows that with the added recreation-environmental data the relationship among the plans is altered somewhat but the overall results remain constant. Plan 11 produces the highest net benefits and is designated the NED plan.

TABLE G-10
CAPE GIRARDEAU JACKSON ENVIRONMENTAL QUALITY/RECREATION BENEFITS
NED CANDIDATE PLANS
8 1/8% Interest
October 1983 (Dollars)

Plan	Picnicking	Open Play Areas	Nature Trails	Group Camping	Exercise Trail	Disc Course	Hiking	Biking	Wildlife	Horse Trail	Total Annual Benefits
1	31,500	47,000	3,700	3,000	6,000	8,400	4,200	1,900	100	0	105,800
2	31,500	47,000	3,700	3,000	6,000	8,400	22,300	10,300	300	0	132,500
3	31,500	47,000	3,700	3,000	6,000	8,400	7,500	3,500	300	0	110,900
4	31,500	47,000	3,700	3,000	6,000	8,400	22,200	10,300	300	0	132,400
5	35,300	47,000	3,700	3,000	6,000	8,400	11,700	5,400	300	0	120,800
6	35,300	47,000	3,700	3,000	6,000	8,400	25,700	12,000	300	0	141,400
7	35,300	47,000	3,700	3,000	6,000	8,400	34,800	14,300	300	0	152,800
8	35,300	47,000	3,700	3,000	6,000	8,400	22,200	10,200	300	0	136,100
9	35,300	47,000	3,700	3,000	6,000	8,400	34,800	14,300	300	0	152,800
10	31,500	47,000	3,700	3,000	6,000	8,400	25,700	12,000	300	0	137,600
11	41,600	47,000	3,700	3,000	6,000	8,400	25,700	12,000	300	0	147,700
12	35,400	47,000	3,700	3,000	6,000	8,400	18,400	8,600	300	0	130,800

TABLE G-11
NED PLAN FORMULATION
TOTAL AVERAGE ANNUAL BENEFITS AND COSTS - 8-1/8%
October 1983 Price Level -
($1,000)

Plan	Flood Control Benefits	Rec EQ Benefits	Total Benefits	Flood Control Costs	Rec/EQ Costs	Total Costs	Net Benefits
1	851	106	957	350	106	456	501
2	1,598	132	1,730	1,517	111	1,628	101
3	1,790	111	1,901	1,609	107	1,716	185
4	3,401	132	3,533	2,070	111	2,181	1,352
5	1,818	121	1,939	1,892	108	2,000	(-61)
6	3,550	141	3,691	2,572	112	2,684	1,007
7	3,723	153	3,876	2,805	115	2,920	956
8	3,645	136	3,781	2,946	111	3,057	724
9	3,748	153	3,901	3,240	115	3,355	546
10	3,442	138	3,580	2,032	112	2,144	1,435
11[1]	3,451	148	3,599	2,007	112	2,119	1,480
12	3,308	131	3,439	1,877	110	1,987	1,452

[1] Initial benefits are proportional in all 12 plans: however, once the NED Plan was selected and recreation details were finalized, some refinements occurred as shown below for the selected NED Plan (Plan 11):

Adjusted Plan 11	3,451	183	3,635	1,999	63	2,062	1,573

The original values used for hiking and biking trails were 1,697 visitor days/mile/year-hiking and 792 visitor days/mile/year-biking. These values were reexamined and found to be underestimated when compared to the visitor days/mile determined for Cape La Croix Creek and Walker Branch in a study by the National Park Service. After careful consideration 3,325 visitor day/mile/year-hiking and 1,550 visitor days/mile/year-biking were used. These changes do not effect the NED optimization selection as shown.

ADDITIONAL PLANS

63. In addition to the NED plan five other plans were formulated and are evaluated below. Each of these five plans emphasize a particular facet of project planning objectives. The plans are: an Environmental Quality (EQ) Plan; a Non-Structural (NS) Plan; a Standard Project Flood (SPF) Plan; a high degree of flood protection plan, designated Plan "A"; and the Recommended Plan. Each plan is briefly descrived below along with a discussion of its objectives.

EQ PLAN

64. A detailed discussion of the designated EQ plan can be found in APPENDIX B - Formulation Assessment and Evaluation of Plans. Briefly, the plan used the structural components of the NED plan as its base because the measures contained in this plan had little adverse environmental impact and at the same time significantly reduced flood damages. Beneficial EQ contributions were added to the flood control base to develop an implementable plan which addresses the planning objectives in a way which emphasizes aesthetic, ecological, and cultural contributions. TABLE G-12 provides economic performance data for the EQ Plan.

NON-STRUCTURAL AND STANDARD PROJECT FLOOD PLANS

65. In order to display the comprehensive diversity of alternatives considered, nonstructural and SPF alternatives were developed and carried through the entire formulation process. Based upon their economic performance, however, the designated SPF and nonstructural plans were eliminated as potential plans for recommendation. TABLE G-13 provides economic performance data for the two plans. A complete description of the plans is provided in APPENDIX B; a brief description follows.

NON-STRUCTURAL PLAN (NS)

66. The non-structural plan requires the removal of all structures damaged by the flood with a 10-percent chance of occurrence. Other non-structural measures such as flood proofing, raising of structures, low level flood walls or levees, and zoning were considered in the Stage 3 Study. Due to the depth and rapidity of flooding, the type of construction and access required for the many commercial establishments, the most feasible alternative appeared to be the removal of 123 commercial and 131 residences. However, the non-structural plan is not economically justified and is unacceptable to local interests due to the large number of businesses and residences that would be affected. Plans with a greater degree of protection would, of course, force the relocation of even more structures. TABLE G-14 provides detailed benefit/cost information for the non-structural plan.

TABLE G-12
ECONOMIC PERFORMANCE OF RECOMMENDED, NED & EQ PLANS
October 1983 Price Levels -
8-1/8% Interest Rate

	Recommended	NED	EQ
Total Project First Cost:	$25,900,000	$24,100,000	$38,300,000
Annual Cost:			
a. First costs	$2,105,200	$1,958,900	$3,113,100
b. Operation and Maintenance	58,100	57,100	82,000
c. Replacement costs	45,700	45,700	65,700
d. Total annual cost	$2,209,000	$2,061,700	$3,260,800
Annual Benefits:			
a. Flood Hazard Reductions	$3,484,300	$3,451,100	$3,755,500
b. Recreation	226,100	183,800	361,700
c. Total Annual Benefits	$3,710,400	$3,634,900	$4,117,200
Net Benefits	$1,501,400	$1,573,200	$ 856,400
Benefit-to-Cost Ratio	1.7	1.8	1.3
Percent Damage Reduction	85	84	92

TABLE G-13
ECONOMIC PERFORMANCE OF SPF & NON-STRUCTURAL PLANS & PLAN "A"
October 1983 Price Levels -
8-1/8% Interest Rate

	SPF	NS	Plan A
Total project first costs (1)	$59,900,000	$57,300,000	$34,100,000
Annual Cost:			
a. First Costs	$ 4,868,800	$ 4,657,500	$ 2,771,700
b. Operation and Maintenance	159,000	8,000	79,000
c. Replacement costs	99,800	0	65,700
d. Total annual cost	$ 5,127,600	$ 4,665,500	$ 2,916,400
Annual Benefits:			
a. Flood Hazard Reductions	$ 4,079,500	$ 2,126,000	$ 3,755,500
b. Recreation	0	0	233,500
c. Total Annual Benefit	$ 4,079,500	$ 2,126,000	$ 3,989,000
Net Benefits	$-1,048,100	$-2,539,500	$ 1,072,600
Benefit-to-Cost Ratio	0.8	0.5	1.4
Percent Damage Reduction	99	52	92

TABLE G-14

SUMMARY NONSTRUCTURAL RELOCATION PLAN

OCTOBER 1983 PRICE LEVEL 8-1/8 DISCOUNT

NED Costs

First Costs:	
Acquisition of Lands and Structures in Flood Plain at Fair Market Value (Exclude P.L.91-646 Costs from Economic Costs	$39,708,000
Removal of Structures from Flood Plain (Net of Market Value of Salvageable Items) & Conversion of Vacated Flood Plains to New Use	6,450,000
Contingencies	9,848,000
Engineering, Supervision and Administration	1,294,000
TOTAL	$ 57,300,000
Annual Costs:	
Interest and Amortization of First Costs	$ 4,657,300
Operations and Maintenance Associated with New Use	8,000
TOTAL	$ 4,665,300

NED Benefits

Annual Benefits:	
Reduction of Insurable Flood Damages	$ 2,086,300
Reduction of Emergency Evacuation Costs and other Emergency Costs	28,300
Savings in Insurance Company Administration Costs	11,300
Benefits from Flood Plain's New Use	Nominal
TOTAL	$ 2,125,900
Net Benefits	$ -2,539,400
B/C Ratio	0.46

STANDARD PROJECT FLOOD PLAN (SPF)

67. The SPF plan consists of the largest practical channel improvements on Cape La Croix Creek and Walker Branch plus dry detention reservoirs capable of storing the 500-year flood at Sites 1 and 2. This plan resulted in the best overall degree of protection with about a 99 percent reduction in total damages, but fell short of SPF protection. The plan is not economically feasible nor is it acceptable to the local interests due to the large number of building removals and bridge replacements required. TABLE G-13 provides detailed benefit/cost data.

PLAN "A"

68. A sixth plan was developed to provide a level of flood protection between the NED plan level and the SPF plan level. This plan is designated Plan "A". The flood control aspects of this plan correspond to option 7 of the NED candidates. Further, the non-structural measures of the removal of the low cost housing near Sprigg Street and in the Golliday Addition, as well as additional recreation components are included in this plan. TABLE G-13 displays the economic performance of this plan. This plan provides approximately 92 percent reduction in expected flood damages.

THE RECOMMENDED PLAN

69. The Recommended Plan combines the dry detention storage, channel improvements on Cape La Croix Creek and Walker Branch, non-structural measures and recreational and environmental features of the NED plan with additional non-structural, recreational, and environmental features.

70. The recommended dry detention reservoir is located at Site 1 and is designated to store the runoff from a ten-year event storm before overflowing the spillway. The recommended channel improvements on Cape La Croix Creek consist of a rectangular concrete channel extending from mile 2.76 to 3.30 and a trapezoid rip-rap lined channel from mile 3.30 to 3.80. No channel improvements are planned for the reach below mile 2.76 or above mile 3.76. On Walker Branch, the concrete channel improvements extend from the mouth up to Kingsway Street at mile 0.89. A grass-lined channel extends from Kingsway Street up to mile 2.00.

71. The recommended non-structural measures include the removal of 55 low cost housing units (i.e. 37 structures near Sprigg Street along Cape La Croix Creek and the removal of 18 residences at Golliday addition). Both areas would be converted to parks. Also, eight mobile homes on Walker Branch upstream of Bessie Street and 10 residences at the Golliday addition would be relocated as a result of the flood control channel construction, and replaced by a small strip park. TABLES G-15 and G-16 provide detailed benefit/cost information on the Golliday Addition and Sprigg Street evacuations.

TABLE G-15

SUMMARY RELOCATION PLAN - GOLLIDAY ADDITION

NED Costs

First Costs:	
Acquisition of Lands and Structures in Flood Plain at Fair Market Value Less P.L.91-646	$452,000
	-95,400
	$356,600
Removal of Structures from Flood Plain (Net of Market Value of Salvageable Items) & Conversion of Vacated Flood Plains to New Use	133,900
Contingencies	33,500
Engineering, Supervision and Administration	26,100
TOTAL	$550,100
Annual Costs:	
Interest and Amortization of First Costs at 8-1/8 (0.0813)	$ 44,700
Operations and Maintenance Associated with New Use	300
TOTAL	$ 45,000

NED Benefits

Annual Benefits:	
Reduction of Flood Damages	$ 31,300
Insurance Deductables	-15,100
Insurance Policy Costs	-1,600
Reduction of Emergency Evacuation Costs and other Emergency Costs, and Miscellaneous Damages	3,400
Savings in Insurance Company Administration Costs	700
Recreation Benefits from Flood Plain's New Use	6,300
TOTAL	$ 31,000
Net Benefits	$-14,000

TABLE G-16

SUMMARY RELOCATION PLAN - SPRIGG STREET
(October 1983 Prices - 8 1/8 %)
NED Costs

First Costs:	
Acquisition of Lands and Structures in Flood Plain at Fair Market Value (Exclude P.L.91-646 Costs from Economic Costs	$772,000
	-196,100
	$575,900
Removal of Structures from Flood Plain (Net of Market Value of Salvageable Items) & Conversion of Vacated Flood Plains to New Use	249,200
Contingencies	62,300
Engineering, Supervision and Administration	48,600
TOTAL	$936,000
Annual Costs:	
Interest and Amortization of First Costs	$ 76,100
Operations and Maintenance Associated with New Use	700
TOTAL	$76,800

NED Benefits

Annual Benefits:	
Reduction of Flood Damages	$42,800
Insyrance Dedutables	-31,000
Insurance Policy Costs	-3,300
Reduction of Emergency Evacuation Costs and other Emergency Costs	4,000
Savings in Insurance Company Administration Costs	1,300
Recreation Benefits from Flood Plain's New Use	30,300
TOTAL	$44,100
Net Benefits	$-32,700

72. The relocation of residences and razing of structures in the designated Sprigg Street area and Golliday addition is included in the recommended plan, even though these particular portions of the plan are not incrementally justified. The areas are flooded repeatedly and many of the homes have been abandoned. This non-structural solution is less costly than alternative structural solutions and affords the opportunity to transform the land to its highest and best use. Relocation assistance would of course be provided to impacted homeowners and tenants for those items covered under Public Law 91-646, "Uniform Relocation Assistance and Land Acquisition Policies Act of 1970."

73. TABLE G-17 shows the recreation and environmental uses and benefits for the recommended plan, as well as the NED plan, EQ plan, and Plan "A". Recreation use is included at the selected Detention Site, Golliday Addition site, and Sprigg and Bessie Streets. EQ enhancements are included at the Detention Site and along the stream corridor. Detailed descriptions of the recreation and EQ features can be found in APPENDIX F and APPENDIX D, respectively.

DEGREE OF PROTECTION

74. The Recommended plan provides a high degree of protection from flooding utilizing both structural and non-structural measures. It also enhances environmental quality, provides recreation, and is economically feasible. The plan reduces tangible damages by 85 percent.

75. Degree of protection has traditionally been used as an indicator of project performance to define the exceedance interval of the flood event at which flood damage begins. It is the minimum protection provided by a project. Structural measures, such as reservoirs or levees, provide uniform protection to all structures. For example, a reservoir by controlling a particular flood event controls it for all structures within the flood plain of that event. In developing a plan using a mixture of measures, however, it is likely that some measures will provide protection to one level and others to another and it is difficult to provide the same protection for all structures. For this reason the indicator degree of protection in its traditional sense as one value for all structures is not particularly meaningful. TABLE G-18 provides a more useful tabulation of remaining damages which better describes the level of protection afforded by the recommended plan. This table shows event (flooding with a particular level of occurrence) damages with and without the Recommended Plan by flood probability. There are no induced damages with the Recommended Plan.

TABLE G-17
CAPE GIRARDEAU-JACKSON - EQ/RECREATION BENEFITS
8-1/8% INTEREST RATE
October 1983 Dollars

		Recreation Feature									EQ Feature		Total
Location	Plan	Hiking Trail	Bicycling Trail	Horse Trail	Picnicking	Open Play Areas	Nature Trails	Group Camping	Exercise Trail	Disc Course	Wildlife	Fisheries	Annual Benefits
Stream Corridor	REC	46,100	21,500	0	0	0	0	0	0	0	200	0	67,800
	NED	46,100	21,500	0	0	0	0	0	0	0	200	0	67,800
	EQ	64,200	31,000	6,100	0	0	0	0	0	0	300	0	101,600
	PLAN A	46,100	21,500	6,100	0	0	0	0	0	0	200	0	73,900
Meander Site	REC	0	0	0	0	0	0	0	0	0	0	0	0
	NED	0	0	0	0	0	0	0	0	0	0	0	0
	EQ	0	0	0	12,600	23,500	6,000	3,000	0	8,400	100	0	53,600
	PLAN A	0	0	0	0	0	0	0	0	0	0	0	0
Sprigg Street	REC	0	0	0	6,300	23,600	0	0	0	0	0	0	29,900
	NED	0	0	0	0	0	0	0	0	0	0	0	0
	EQ	0	0	0	6,300	23,600	0	0	0	0	0	0	29,900
	PLAN A	0	0	0	6,300	23,600	0	0	0	0	0	0	29,900
Bessie Street	REC	0	0	0	3,800	0	0	0	0	0	0	0	3,800
	NED	0	0	0	3,800	0	0	0	0	0	0	0	3,800
	EQ	0	0	0	3,800	0	0	0	0	0	0	0	3,800
	PLAN A	0	0	0	3,800	0	0	0	0	0	0	0	3,800
Golliday Addition	REC	0	0	0	12,600	0	0	0	6,100	0	0	0	18,700
	NED	0	0	0	6,300	0	0	0	0	0	0	0	6,300
	EQ	0	0	0	12,600	0	0	0	6,100	0	0	0	18,700
	PLAN A	0	0	0	12,600	0	0	0	6,100	0	0	0	18,700
Detention Site 1	REC	4,200	2,000	0	31,500	47,000	3,700	3,000	6,000	8,400	100	0	105,900
	NED	4,200	2,000	0	31,500	47,000	3,700	3,000	6,000	8,400	100	0	105,900
	EQ	4,200	2,000	0	31,500	47,000	3,700	3,000	6,000	8,400	1,600	0	107,400
	PLAN A	4,200	2,000	0	31,500	47,000	3,700	3,000	6,000	8,400	1,400	0	107,200
Hopper Road	EQ only	0	0	0	18,900	23,500	3,700	0	0	0	600	0	46,700
TOTALS	REC	50,300	23,500	0	54,200	70,600	3,700	3,000	12,100	8,400	300	0	226,100
	NED	50,300	23,500	0	41,600	47,000	3,700	3,000	6,000	8,400	300	0	183,800
	EQ	68,400	33,000	6,100	85,700	117,600	13,400	6,000	12,100	16,800	2,600	0	361,700
	PLAN A	50,300	23,500	6,100	54,200	70,600	3,700	3,000	12,100	8,400	1,600	0	233,500

TABLE G-18
RECOMMENDED PLAN
FLOOD CONTROL PERFORMANCE (EVENT DAMAGES)
October 1983 Price Levels

Event In Years	Event Damages Without the Recommended Plan	Event Damages With the Recommended Plan	Event Benefits	Percent Damage Reduction
1	$ 0	$ 0	$ 0	0
2	2,361,400	143,000	2,218,400	94.0%
5	5,399,000	1,089,300	4,309,700	79.8%
10	9,950,000	1,656,200	8,293,800	83.4%
50	18,063,000	3,963,300	14,099,700	78.1%
100	22,093,500	6,675,100	15,418,400	69.8%
500	27,604,500	10,804,200	16,800,300	60.9%

The percent damage reduction values shown in TABLE G-18 indicate the significant effectiveness of the basic flood control management measures.

ECONOMIC PERFORMANCE

76. Total economic performance for the recommended plan is given in TABLE G-19. As TABLE G-19 indicates, the Benefit-to-Cost ratio (BCR) for flood control alone is 1.7 to 1. The entire plan including all benefits and costs also has a BCR of 1.7 to 1.

BREAK-EVEN INTEREST RATE

77. TABLE G-20 provides an analysis of the changes in benefits and costs with changes in the discount rate.

TABLE G-19
SUMMARY OF BENEFITS AND COSTS FOR THE RECOMMENDED PLAN
October 1983 Price Levels -
8-1/8% Interest Rate
Based on $25,900,000 project first cost

Benefit Category	Average Annual Benefits	Average Annual Costs	Net Benefits
Flood Control	$3,451,800	$2,006,900	$1,444,900
Evacuations	32,500	128,500	-96,000
Recreation	226,100	73,600	152,500
PROJECT TOTAL	$3,710,400	$2,209,000	$1,501,400

TABLE G-20
BREAK-EVEN INTEREST RATE FOR RECOMMENDED PLAN*
CAPE GIRARDEAU-JACKSON
October 1983 Price Levels

Interest Rate	Partial Payment	Annual Cost	Replacement Cost	O & M**	Total Annual Cost	Annual Benefits: Flood Control	Annual Benefits: EQ/Rec***	Annual Benefits: Total	BCR
8 1/8	0.08128	$2,105,200	$45,700	$58,100	$2,209,000	$3,484,300	$226,100	$3,710,400	1.68
9	0.09002	2,331,500	39,900	58,100	2,429,500	3,484,300	226,100	3,710,400	1.53
10	0.10001	2,590,300	34,100	58,100	2,682,500	3,484,300	226,100	3,710,400	1.38
11	0.11003	2,849,800	29,200	58,100	2,937,100	3,484,300	226,100	3,710,400	1.26
12	0.12000	3,108,000	24,900	58,100	3,191,000	3,484,300	226,100	3,710,400	1.16
13	0.12000	3,367,000	21,300	58,100	3,446,400	3,484,300	226,100	3,710,400	1.08
14	0.14000	3,626,000	18,100	58,100	3,702,200	3,484,300	226,100	3,710,400	1.00
15	0.15000	3,885,000	15,500	58,100	3,958,600	3,484,300	226,100	3,710,400	.94

* Based on first cost of $29.4 million, Operations & Maintenance of $70,000 per year, and 100-year life.

** O&M = Operations & Maintenance

*** EQ/Rec = Environmental Quality & Recreation

The break-even interest rate is approximately 14.5 percent, i.e., at this rate, the benefit-to-cost ratio equals 1:1.

INTANGIBLE BENEFITS

78. Intangible benefits, such as improved public health, reduced risk to human lives, and increased morale to the area's people have not been quantified but would also accrue due to the plans of improvement. In addition, the overall aesthetic quality of the community would improve as a result of less frequent flooding, which is a major contributing factor to deterioration of flood plain structures.

79. Tabular displays of projects effects, as measured by their contributions to the system of accounts in both tangible economic terms as well as intangible terms are presented in APPENDICES B and F.

80. It is considered that overall the intangible impacts are significantly beneficial impacts. No adverse intangible impacts are known to exist which have not been addressed (primarily in APPENDIX F). On the basis of considering all known intangible impacts no mitigation would be required by implementation of the recommended plan and no unresolved environmental or other issues are known to exist.

CONCLUSIONS

81. A summary of economic information for the final array of six alternative solutions is displayed in TABLES G-21 and G-22. These six final alternatives are considered as defining a reasonably wide range of potential alternative solutions, and the impacts thereof, to allow the formulation and judgemental identification of the Recommended Plan. The seven final alternatives were named as follows: No Action Plan; NED Plan; Plan "A"; EQ Plan; SPF Plan; and the Non-structural Plan; and Recommended Plan.

TABLE G-21
CAPE LA CROIX CREEK AND WALKER BRANCH
FINAL ALTERNATIVES AND RECOMMENDED PLAN COMPARISON
BASED ON OCTOBER 1983 PRICE LEVELS AND 8-1/8 PERCENT INTEREST

ITEM	RECOMMENDED PLAN	NO ACTION	NED PLAN	EQ PLAN
1. CONSTRUCTION COSTS				
a. Flood Control	$25,166,000	0	$23,486,000	$32,620,000
b. Fish/Wildlife	0	0	0	4,020,000
c. Recreation	734,000	0	614,000	1,660,000
d. Total	$25,900,000	$0	$24,100,000	$38,300,000
2. O/M AND REPLACEMENT COSTS				
a. Flood Control	$ 89,800	(2)	$89,800	$133,700
b. Fish/Wildlife	0	(2)	0	0
c. Recreation	14,000	(2)	13,000	14,000
d. Total	$103,800	$ (2)	$102,800	$147,700
3. TOTAL ANNUAL COSTS				
a. Flood Control	$2,135,400	(2)	$1,998,800	$2,785,100
b. Fish/Wildlife	0	(2)	0	326,800
c. Recreation	73,600	(2)	62,900	148,900
d. Total	$2,209,000	$ (2)	$2,061,700	$3,260,800
4. FLOOD DAMAGES REMAINING	$642,600	$4,126,100	$ 675,000	$ 370,600
5. AVERAGE ANNUAL BENEFITS				
a. Flood Control	$3,484,300	$ 0	$3,451,100	$3,755,500
b. Fish/Wildlife	300	0	300	2,600
c. Recreation	225,800	0	183,500	359,100
d. Total	$3,710,400	$ 0	$3,634,900	$4,117,200
6. PERCENT FLOOD DAMAGE REDUCTION	85%	0%	84%	92%
7. NET BENEFITS	$1,501,400	$ 0	$1,573,200	$ 856,400

FOOTNOTES: (1) No recreation or fish/wildlife costs or benefits were calculated for the SPF and NS Plans because flood control was unjustified.
(2) The "No Action" alternative will suffer the continuing costs of flood damages and individual protection and clean up efforts.

TABLE G-22
CAPE LA CROIX CREEK AND WALKER BRANCH
FINAL ALTERNATIVES AND RECOMMENDED PLAN COMPARISON
BASED ON OCTOBER 1983 PRICE LEVELS AND 8-1/8 PERCENT INTEREST

ITEM	SPF PLAN	NS PLAN	PLAN "A"
1. CONSTRUCTION COSTS			
a. Flood Control	$59,900,000	$57,300,000	$32,620,000
b. Fish/Wildlife	(1)	(1)	480,000
c. Recreation	(1)	(1)	1,000,000
d. Total	$59,900,000	$57,300,000	$34,100,000
2. O/M AND REPLACEMENT COSTS			
a. Flood Control	$258,800	$8,000	$133,700
b. Fish/Wildlife	(1)	(1)	0
c. Recreation	(1)	(1)	11,000
d. Total	$258,800	$8,000	$144,700
3. TOTAL ANNUAL COSTS			
a. Flood Control	$5,127,600	$4,665,500	$2,785,100
b. Fish/Wildlife	(1)	(1)	39,000
c. Recreation	(1)	(1)	92,300
d. Total	$5,127,600	$4,665,500	$2,916,400
4. FLOOD DAMAGES REMAINING	$46,600	$2,000,100	$ 370,600
5. AVERAGE ANNUAL BENEFITS			
a. Flood Control	$4,079,500	$2,126,000	$3,755,500
b. Fish/Wildlife	(1)	(1)	1,600
c. Recreation	(1)	(1)	231,900
d. Total	$4,079,500	$2,126,000	$3,989,000
6. PERCENT FLOOD DAMAGE REDUCTION	99%	52%	92%
7. NET BENEFITS	(-$1,048,100)	(-$2,539,500)	$1,072,600

FOOTNOTES: (1) No recreation or fish/wildlife costs or benefits were calculated for the SPF and NS Plans because flood control was unjustified.
(2) The "No Action" alternative will suffer the continuing costs of flood damages and individual protection and clean up efforts.

ATTACHMENT 1

FEDERAL INSURANCE ADMINISTRATION
DEPTH-DAMAGE DATA

ATTACHMENT I

CAPE GIRARDEAU JACKSON
FEDERAL INSURANCE ADMINISTRATION "DEPTH-DAMAGE CURVES: 1974"
RESIDENTIAL STRUCTURES

First Floor Depth In Feet	One Story-No Basement (01)	Two or More Stories No Basement (03)	One Story With Basement (13)	Two or More Stories With Basement (18)	Split Level No Basement (05)	Split Level With Basement (23)	Mobile Homes (10)
-3			0	0		0	
-2			4	3		3	
-1	0	0	8	5	0	5	0
0	7	5	7	3	3	6	8
1	10	9	18	11	9	16	45
2	14	13	20	17	13	19	64
3	26	18	23	22	25	22	74
4	28	20	28	28	27	27	79
5	29	22	33	33	28	32	80
6	41	24	38	35	33	35	81
7	43	26	44	38	34	36	82
8	44	31	49	40	41	44	82
9	45	36	51	44	43	48	82
10	46	38	53	46	45	50	82
11	47	40	55	48	46	52	82
12	48	42	57	50	47	54	82
13	49	44	59	52	48	56	82
14	50	46	60	54	49	58	82
15	50	47	60	56	50	59	82
16	50	48	60	58	50	60	82
17	50	49	60	59	50	60	82

Source: East St. Louis and Vicinity, Blue Waters Ditch General Design Memorandum, September 1976.

ATTACHMENT 1
(cont'd)
CAPE GIRARDEAU-JACKSON
FEDERAL INSURANCE ADMINISTRATION "DEPTH-DAMAGE CURVES: 1974"
RESIDENTIAL CONTENTS

Depth In Feet	All On First Floor (01)	All On First Two Floors (03.05)	First Floor and Basement (13.23)	First Two Floors and Basement (18)	All In Basement	All Above First Floor	Mobile Homes (10)
-4			0	0	0		
-3			5	0	45		
-2	0	0	7	6	50	0	0
-1			8	9	55		
0	10	7	15	11	60	1	3
1	17	9	20	17	60	2	27
2	23	17	22	22	60	3	50
3	29	22	28	28	60	4	65
4	35	28	33	33	60	5	71
5	40	33	39	39	60	6	76
6	45	39	44	44	60	6	78
7	50	44	50	49	60	6	79
8	55	50	55	55	60	6	81
9	60	55	60	61	60	10	83
10	60	58	60	64	60	17	83
11	60	65	60	71	60	23	83
12	60	72	60	76	60	29	83
13	60	78	60	78	60	35	83
14	60	79	60	79	60	40	83
15	60	80	60	80	60	45	83
16	60	81	60	81	60	50	83
17	60	81	60	81	60	55	83
18	60	81	60	81	60	60	83

Source: East St. Louis and Vicinity, Blue Waters Ditch General Design Memorandum, September 1976.

ATTACHMENT 1
(cont'd)
CAPE GIRARDEAU-JACKSON
FEDERAL INSURANCE ADMINISTRATION "DEPTH-DAMAGE CURVES: 1974"
COMMERCIAL STRUCTURES

	Structure Type															
First Floor Water Depth In Feet	(101) Gas Station	(102) Gas Station Services	(103) Drug Grocery Chain Food	(104) Disc. & Dept. Stores	(105) H'ware, Paint, Auto, Sport Stores	(106) Barber & Beauty Shops	(107) Laundry-Cleaners	(108) Quick Shops, Bakeries	(109) Fast Food, Dairy Queen Etc.	(110) Restaurants & Large Fast Food (McDonald's)	(111) Fashion Shoe Etc.	(112) Liquor Stores, Taverns	(113) Bowling Alleys	(114) Ware-house Storage Bldg.	(115) General Office Space: Doctors, Bank, Etc.	(116) Schools
-4	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	8	8	8	8	8	8	8	8	8	8	8	10	8	8	8	
1	22	22	22	22	22	22	22	22	22	22	22	24	22	22	22	10
2	30	30	30	30	30	30	30	30	30	30	30	31	30	30	30	16
3	35	35	35	35	35	35	35	35	35	35	35	37	35	35	35	20
4	39	39	39	39	39	39	39	39	39	39	39	41	39	39	39	24
5	41	41	41	41	41	41	41	41	41	41	41	44	41	41	41	27
6	44	44	44	44	44	44	44	44	44	44	44	46	44	44	44	30
7	46	46	46	46	46	46	46	46	46	46	46	48	46	46	46	32
8	48	48	48	48	48	48	48	48	48	48	48	49	48	48	48	34
9	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	39
10	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	42
11	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	45
12	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	47
13	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	49
14	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
15	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
16	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
17	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
18	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50

Source: East St. Louis and Vicinity, Blue Waters Ditch General Design Memorandum, September 1976

ATTACHMENT 1
(cont'd)
CAPE GIRARDEAU-JACKSON
FEDERAL INSURANCE ADMINISTRATION "DEPTH-DAMAGE CURVES: 1974"
COMMERCIAL CONTENTS

Structure Type

First Floor Water Depth In Feet	(101) Gas Station	(102) Gas Station Services	(103) Drug Grocery Chain Food	(104) Disc. & Dept. Stores	(105) H'ware, Paint, Auto, Sport Stores	(106) Barber & Beauty Shops	(107) Laundry-Cleaners	(108) Quick Shops, Bakeries	(109) Fast Food, Dairy Queen Etc.	(110) Restaurants & Large Fast Food (McDonald's)	(111) Fashion Shoe Etc.	(112) Liquor Stores, Taverns	(113) Bowling Alleys	(114) Ware-house Storage Bldg.	(115) General Office Space: Doctors, Bank, Etc.	(116) Schools
-4	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	14	42	17	3	13	0	0	36	2	6	4	5	20	35	1	1
1	14	58	74	20	48	2	41	107	5	10	26	12	41	162	2	2
2	16	74	97	37	77	3	69	149	8	19	48	19	71	199	3	3
3	25	90	120	41	90	7	87	192	10	25	53	26	89	246	4	4
4	26	96	143	55	105	8	98	235	13	27	72	33	100	293	4	4
5	26	105	165	62	111	9	161	278	15	30	81	38	118	340	5	5
6	26	109	168	63	119	9	161	284	17	34	82	42	118	348	6	6
7	26	112	173	65	123	9	161	290	18	36	84	45	118	355	7	7
8	26	116	176	66	127	9	161	296	21	39	86	53	118	370	7	7
9	26	118	180	68	131	9	161	303	21	39	88	53	118	370	8	8
10	26	120	184	69	131	9	161	308	21	39	89	53	118	378	9	9
11	26	120	184	69	131	9	161	308	21	39	89	53	118	378	9	9
12	26	120	184	69	131	9	161	308	21	39	89	53	118	378	9	9
13	26	120	184	69	131	9	161	308	21	39	89	53	118	378	9	9
14	26	120	184	69	131	9	161	308	21	39	89	53	118	378	9	9
15	26	120	184	69	131	9	161	308	21	39	89	53	118	378	9	9
16	26	120	184	69	131	9	161	308	21	39	89	53	118	378	9	9
17	26	120	184	69	131	9	161	308	21	39	89	53	118	378	9	9
18	26	120	184	69	131	9	161	308	21	39	89	53	118	378	9	9

Source: East St. Louis and Vicinity, Blue Waters Ditch General Design Memorandum, September 1976

CAPE GIRARDEAU-JACKSON
METROPOLITAN AREA, MISSOURI

SURVEY REPORT

APPENDIX H

ENDANGERED SPECIES ASSESSMENT

CAPE GIRARDEAU - JACKSON

APPENDIX H

ENDANGERED SPECIES ASSESSMENT

One purpose of this appendix is to present the detailed Endangered Species assessment for the Cape Girardeau - Jackson study. This information is intended to show what species are of concern and what project impacts, if any, will impair their continued existence within the project area. This assessment was originally submitted to the U.S. Fish and Wildlife Service (USFWS) on 10 Februrary 1982. Since that submittal, changes have been made to the features of the Recommended Plan (see FIGURE 3). These changes are generally minor and have been noted within the Final Survey Report. The projects environmental changes include the deletion of land acquisitions and management measures for wildlife enhancement. These modifications will not affect any known critical habitat for these species. Therefore, the changes are minor and do not alter the previous conclusions of the biological assessment and further consultation with the Service is deemed unnecessary.

CAPE GIRARDEAU - JACKSON

APPENDIX H
ENDANGERED SPECIES ASSESSMENT

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BIOLOGICAL ASSESSMENT

CAPE GIRARDEAU/JACKSON STUDY

1. Introduction

In response to a request on 20 July 1979, the US Fish and Wildlife Service provided the St. Louis District with a list of the following endangered species which may occur in the project area (Inclosure 1). The list was reconfirmed by personal communication with Larry Visscher of the US Fish and Wildlife Service on 26 January 1982.

Bald Eagle (*Haliaeetus leucocephalus*) - Endangered
American Peregrine Falcon (*Falco peregrinus anatum*) - Endangered

2. Description of the Study Area

The initial focus of the Cape Girardeau/Jackson Study was on that 210-square mile area depicted by Figure 1. For economic reasons, the region of the present detailed investigation (Stage 3) was narrowed to that of the Cape La Croix Creek drainage basin (see Figure 2, watershed boundary limits).

The Cape La Croix Creek drainage basin has its headwaters in steep hills located about 4 miles north of the city of Cape Girardeau, Missouri. From there it flows southward through the city to its confluence with the Mississippi River at river mile 50.2. The Cape La Croix watershed covers an area of about 21.4 square miles and has an average slope of about 29.5 feet per mile. The upper part of the basin (above the north crossing of US Highway 61 over the creek) is very steep, and only sparsely developed. Most of the area is wooded or in open pasture with only scattered residential and agricultural development. Between the north Highway 61 and Bloomfield Road crossings over Cape La Croix Creek, there is extensive urban development; this includes residential, commercial, industrial, and park land areas. Open bottomland is also present in certain sections. Walker Branch, the major tributary to Cape La Croix, enters the creek within this reach. The Walker Branch basin is highly developed with residential areas upstream and commercial areas downstream of Broadway Street. The joint flood plain of Cape La Croix Creek and Walker Branch has been severely encroached upon with development extending out to the high banks in many cases. South of Bloomfield Road, development is not as heavy with more open bottomland available.

Flooding from Cape La Croix Creek and Walker Branch generally occurs in the spring and summer months as a result of intense thunderstorms, although flooding may occur during any month of the year. These floods have a rapid rate of rise and are of a short duration but, as recent years have shown, are capable of causing tremendous damage. Backwater from the Mississippi River entering Cape La Croix Creek is considered minimal in terms of property damage.

Study Authority. The Cape Girardeau/Jackson Project resulted from three congressional resolutions. The first resolution, adopted in 1966, authorized a study of flood control and allied purposes for the area along the Little River Diversion Channel between Hubble Creek and Ramsey Branch, Cape Girardeau County, Missouri.

The second resolution, adopted in 1972, authorized a study of flood control and allied purposes along Cape La Croix Creek, Cape Girardeau County, Missouri.

The third resolution, adopted in 1974, authorized a review of recommendations of the Chief of Engineers on the Mississippi River between Coon Rapids Dam and the mouth of the Ohio River. Recommendations included Cape La Croix Creek and other waterways of Cape Girardeau County in a consideration of the needs for flood control, wise use of flood plain lands, . . . and other measures of enhancement and protection of the environment in the metropolitan area.

Improvements. The primary study problems identified is severe flooding of the Cape Girardeau commercial/residential area. In an effort to reduce this problem within the Cape La Croix Creek and Walker Branch flood plains, various alternative flood control measures were considered; this included various channel sizes and linings, several dry detention reservoir sites, wet reservoir sites, levees, floodwalls, and diversions. Channels and dry detention storage were determined to have the greatest potential.

The present recommended plan (Figure 2) entails several structural features. This includes a concrete lined rectangular channel through the highly developed portions of both Cape La Croix Creek (from river mile (R.M.) 2.76 to 3.76) and Walker Branch (from R.M. 0 to 0.89). The bottom width of concrete channels would be 75 feet on Cape La Croix Creek and 50 to 60 feet on Walker Branch. Trapezoidal grass-lined channels are proposed upstream of the concrete channels (Cape La Croix,, 110-foot bottom, R.M. 3.76 to 5.11; Walker Branch, 35- to 75-foot bottom, R.M. 0.89 to 2.0).

A single 78-acre upland dry detention site was chosen and designed for flood control (see Figure 3).

The recommended plan also requires the relocation of residential structures from a total of 14 flood plain acres.

Recreational features include the establishment of several miles of hiking/biking trails, as well as 5 miles of horse trails. Forty-three acres at the dry detention site would be set aside as parkland. Recreational development would also be placed on lands vacated by the building relocations.

EQ features include the revegetation of designated 20-foot corridors along Cape La Croix Creek (R.M. 3.76 to Detention Site) and Walker Branch (R.M. 0.89 to 2.00). At the dry detention site, 38 acres would be specified as EQ land. Wildlife management is planned within the park and EQ areas.

Construction. The construction phase would begin near the year 1990 and would require approximately two years to complete. Operation and maintenance of the project would last for approximately 100 years.

3. Impacts

Bald Eagle. The major population limiting factors for Bald Eagles center around the reproductive stage of their cycle.

Eagles have not been known to nest successfully in Missouri since the early 1900's (Gale, 1979) and the most recent unsuccessful nesting attempt verified was reported in 1965 at a site near Tunnel Dam near Camdenton (Griffin and Elder, 1980).

The primary importance of the Middle Mississippi River and its adjacent area is as a wintering ground, that provides sources of food and roosting sites. Good wintering areas are required to maintain a healthy population and insure the return of a maximum number of eagles to northern breeding grounds (Steenhof, 1978). Accumulated data indicates that Missouri and Illinois have one of the largest concentrations of wintering eagles in the lower 48 states (Spencer, 1976).

Based on yearly aerial census surveys conducted by the Illinois Natural History Survey from 1973 to 1981, the Mississippi River between Grand Towers (R.M. 74) and Cairo (R.M. 0) contains average to above average numbers of wintering eagles per river mile compared with other sections of the Middle Mississippi River (Table 1) (Sanderson et al., 1974; 1975-1981). Cape La Croix Creek feeds into the Mississippi River within this river reach (R.M. 51).

Fish is the preferred item in the eagles' wintertime diet (Spencer, 1976), and when fish are readily available, particularly dead and dying prey, other food sources are ignored. When ice covers and limits the presence of open fishing waters, waterfowl, usually hunter-wounded or crippled birds, may become an important alternative food source.

Eagles prefer trees for their daytime perches and selection seems to be based on the proximity of the perch to a food source (Steenhof, 1978). In South Dakota most perches are within 30 meters of water (Steenhof, 1978). Eagles also tend to use the highest perch sites available; trees used by eagles in South Dakota were found to have a mean height of 21.1 meters. Tree perching eagles also tend to select stout, horizontal branches extending over open areas; cottonwoods are commonly used in the Midwest (Steenhof, 1978).

Night roosts of eagles are often communal and may or may not be near water (Spencer, 1976). At Great Salt Lake in Utah where nearby tree cover is lacking, eagles travel 10-15 miles to reach forested sites for roosting (Snow, 1973). Trees selected range from 13 to 30 meters in height and are

well protected from wind and storm, as illustrated by winter roosts along east-facing slopes of the Illinois River where the force of the prevailing westerly winds is neutralized (Steenhof, 1978).

Human activities, particularly boat and snowmobile traffic, pedestrians, and gunshots, may disturb eagles, although certain activities are tolerated more at feeding sites than at roosting areas.

The study area is already highly developed and a project would probably not significantly alter use of the area by eagles. Across from the mouth of Cape La Croix Creek on the Illinois side of the Mississippi River, the banks are heavily forested and there are extensive sand bars. Such potential eagle habitat will not be impacted upon by the project.

In addition, the number of eagles likely to be found in the project area is probably quite small as a result of the number of high quality waterfowl areas in the region that are known to attract large concentrations of wintering eagles. These sites include Crab Orchard National Wildlife Refuge, Horseshoe Lake Conservation Area, and Union County Conservation Area in Illinois, and Mingo National Wildlife Refuge and Duck Creek Management Area in Missouri.

American Peregrine Falcon. Although most of the Mississippi Valley was once considered part of the breeding range of the Peregrine Falcon subspecies anatum, the best evidence indicates that it now only occurs as a migrant (Fyfe et al., 1976). In Missouri, between one and ten individuals are reported each spring and fall and an occasional individual is reported in winter (Gale, 1979). It is likely that a far large number of peregrines migrate through the state and are never reported (Gale, 1979).

The primary value of the project area to falcons would be as an occasional feeding area during migration. Dekker (1980), investigating a marshy lake area in Alberta, Canada, reported that migrating Peregrine Falcons prey primarily upon waterfowl and small shorebirds. other birds, including pigeons and song birds, are also taken. The usual method is or the peregrine to attack its prey in flight.

The impact of the project would probably have little effect upon the welfare of the falcon. Migrating shorebirds may possibly avoid sections of streams when channelized due to a decrease in mudflat and shore feeding areas, but with large waterfowl populations in surrounding areas and the generalized feeding habits of the bird, such a loss of shorebirds as prey would be expected to be insignificant.

4. Efforts to Eliminate Adverse Impacts on Species and Habitat

Bald Eagles and Peregrine Falcons may occasionally be found in the study area, but because of the high extent of development, it is doubtful that they utilize the area to any significant extent. No habitat critical for these

endangered species has been identified within the project area. The project land acquisition and wildlife management measures would enhance conditions for small birds, primarily song birds, which could serve as an alternative food source for peregrines.

TABLE H-1

BALD EAGLES CENSUS - MIDDLE MISSISSIPPI
(derived from data of Sanderson et al. 1974-81)
EAGLES PER RIVER MILE

	Eagles Per River Mile of Reach			Total No. of Eagles	
Year	1	2	Ave	Observed	Date Observed*
1980-81	1.34	.46	.79	58	28 Jan 81
1979-80	1.55	1.39	1.46	108	18 Feb 80
1978-79	1.44	1.24	1.31	97	5 Feb 79
1977-78	.65	.59	.61	45	7 Dec 77
1976-77	.90	.43	.61	45	2 Feb 77
1975-76	.54	.26	.37	27	6 Jan 76
1974-75	.54	.17	.31	23	10 Feb 75
1973-74	.22	.20	.20	15	9 Jan 74

*Date when greatest number of eagles were observed between Grand Towers and Cairo.

1. Grand Tower to Cape Girardeau (27.7 miles)
2. Cape Girardeau to Cairo (46.1 miles)

TOTAL 73.8 miles

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IN REPLY REFER TO:
FA/SE/COE--Cape Girardeau-
Jackson Flood Control Proj., MO
6-3-79-I-277

Colonel Leon E. McKinney
District Engineer
U.S. Army Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Colonel McKinney:

This responds to your letter of July 20, 1979, in regard to the Cape Girardeau-Jackson Flood Control Project in Cape Girardeau County, Missouri.

In accordance with Section 7(c) of the Endangered Species Act Amendments, we have reviewed your information and determined that the following species may be present in the project area.

Listed Species

Bald eagle
Peregrine falcon

Section 7(c) of the Act Amendments requires that you prepare a biological assessment to determine if the proposed project will affect the above species. If you determine that the project will affect these species, you should initiate formal consultation.

Thank you for your interest and cooperation in conserving endangered species. If we can be of further assistance, please contact us.

Sincerely yours,

William A. Godby

WILLIAM A. GODBY
Acting Regional Director

VICINITY MAP

CAPE GIRARDEAU-
JACKSON METROPOLITAN AREA
MISSOURI

U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
LOWER MISSISSIPPI VALLEY DIVISION

FIGURE 1

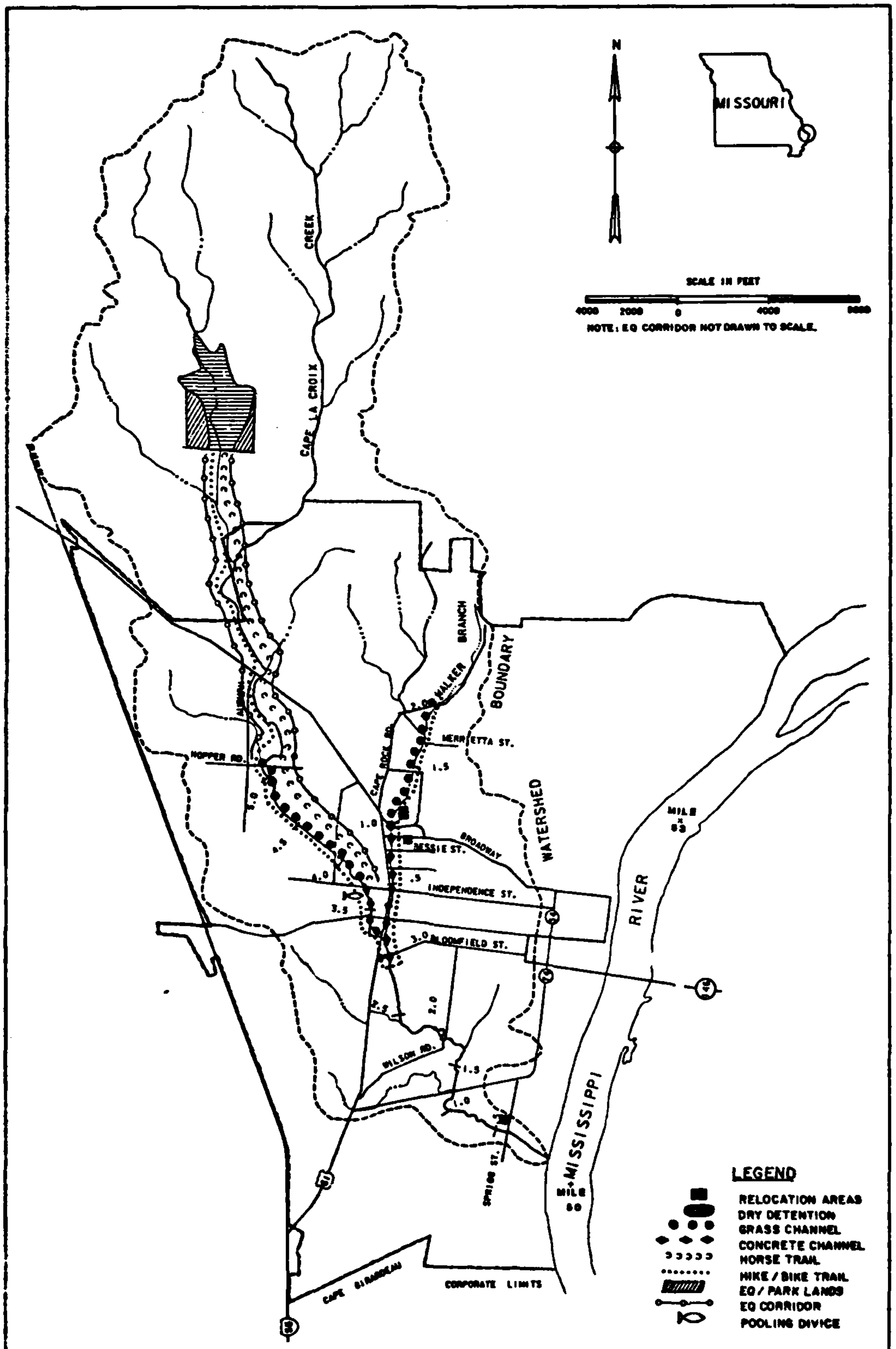
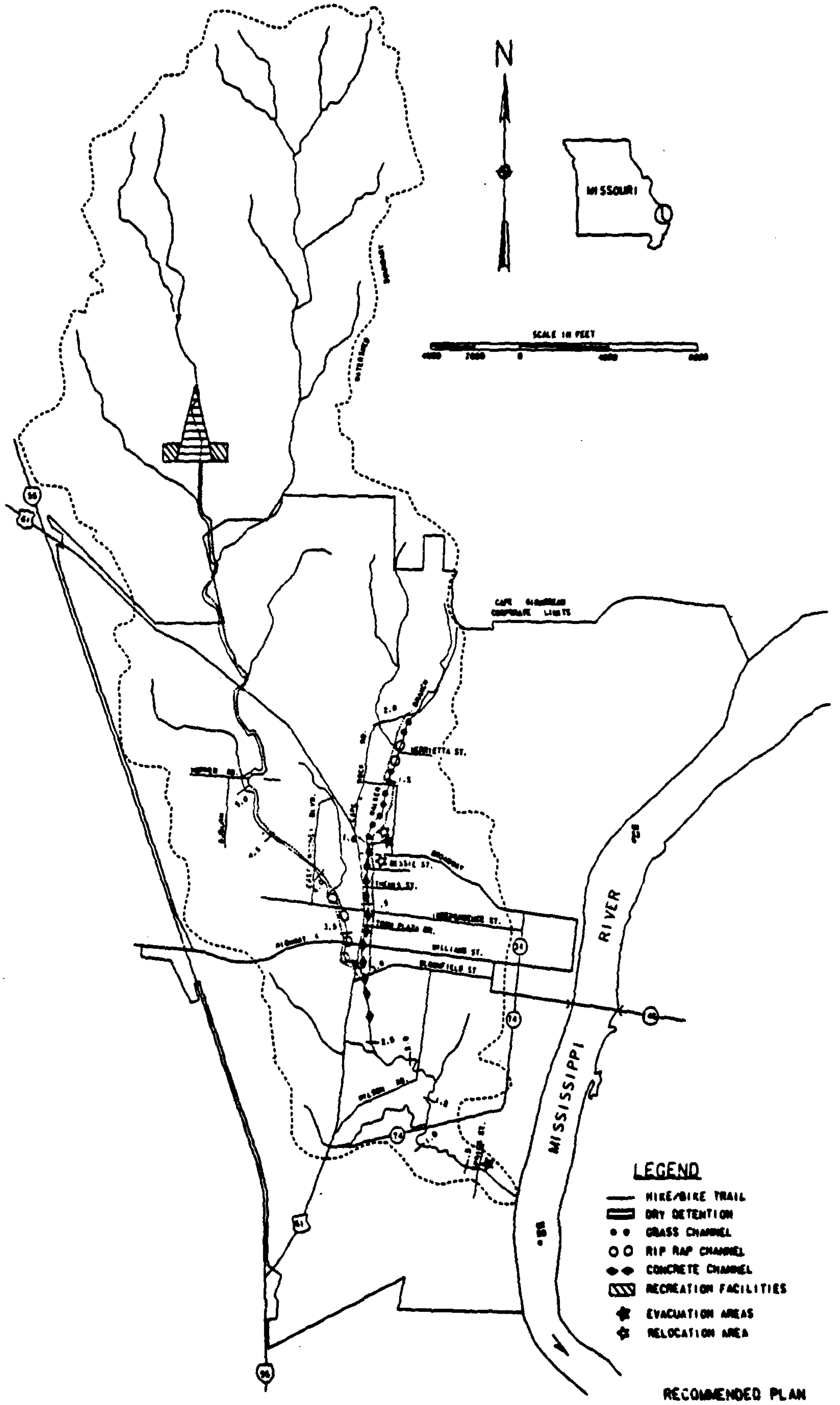


FIGURE 2 SEPT 82 RECOMMENDED PLAN
IS PLAN "A" AS OF NOV 83



APPENDIX H
H-11

FIGURE 3

CAPE GIRARDEAU-JACKSON
METROPOLITAN AREA, MISSOURI

SURVEY REPORT

APPENDIX I
CLEAN WATER ACT (SECTION 404)

CAPE GIRARDEAU - JACKSON
APPENDIX I
CLEAN WATER ACT (SECTION 404)

The purpose of APPENDIX I is to present the District's preliminary Clean Water Act, Section 404 analysis for the project. After this analysis was made and documented on the following pages, the Recommended Plan was revised. The changes to the Recommended Plan are minor and the Section 404 analysis presented remains generally valid. A final revision of the analysis will be accomplished during the project's design phase. State water quality certification will also take place at that time. Changes to the component features of the Recommended Plan are as follows:

Features Affecting Waters of the US
to Which the 404(b) Guidelines Apply

(a) 0.61 miles of concrete transition and concrete-lined Cape La Croix Creek channel between creek miles 2.72 and 3.23.

(b) 0.57 miles of riprap channel along Cape La Croix Creek between creek miles 3.23 and 3.80.

(c) 0.4 miles of concrete lined Walker Creek channel between creek miles 0.00 and 0.4.

Features Affecting Waters of the US but
to Which the 404(b) Guidelines are not Applicable

(d) An upland dry detention reservoir and dam.

(e) 0.56 miles of enlarged and concrete lined Walker Branch channel between creek miles 0.40 and 0.96.

(f) 0.72 miles of grass lined channel along Walker Branch between miles 0.96 and 1.68, then 0.06 miles of riprap channel between miles 1.68 and 1.74 and 0.26 miles of grass channel between miles 1.74 and 2.00.

Features not Affecting Waters of the US

(g) 8 bridge replacements.

(h) 8 bridge removals.

(i) Building structures removed from portions of flood plain.

(k) Recreation trails.

(l) New park lands.

CAPE GIRARDEAU - JACKSON
APPENDIX I
CLEAN WATER ACT (404)

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CAPE GIRARDEAU - JACKSON
APPENDIX I

CLEAN WATER ACT (SECTION 404)

INTRODUCTION

1. The Cape Girardeau-Jackson Study's recommended flood control project within the Cape La Croix Creek Watershed would involve the placement of dredged and fill materials into waters of the United States. Section 404 of the Clean Water Act established a permit program for the purpose of regulating discharges of dredged or fill material into waters of the United States. On 25 July 1975 and 19 July 1977, the Corps of Engineers published regulations (33 CFR 323) that redefined and broadened the Section 404 authority to affect "waters of the United States." Under Section 404(b), proposed discharges of dredged or fill material must conform to guidelines developed by the Administrator, Environmental Protection Agency (EPA). On 5 September 1975, in accordance with Section 404(b), the EPA published regulations (40 CFR 230) which outline criteria and procedures for evaluating activities subject to Section 404. On 24 December 1980, revised Section 404(b) guidelines were published (40 CFR 230) which became effective 30 March 1981. It is mandatory that the guidance be applied to all proposed discharges of dredged and fill material subject for approval under Section 404.

2. Using those regulations, the project area to which the 404(b) guidelines apply was determined by finding those regions of the creek system either occurring below the headwaters and below the ordinary high water mark (OHW) or that represent adjacent wetlands. "Headwaters" is defined as the point upstream of which the average annual flow is less than five cubic feet per second. Based on this definition, the area of Cape La Croix Creek north of Highway W, and all tributaries of Cape La Croix Creek below Highway W (including Walker Branch) lie above the headwaters (PLATE I-1). Conversely, the section of Cape La Croix Creek between its mouth and the Highway W crossing lies below the headwaters. The OHW was estimated by observing such physical characteristics as a clear natural bankline and the presence of litter and debris for each elevation listed in TABLE I-1. The OHW for intermediate points was determined by interpolating between these known points. It should be noted that the lower approximately one-half mile section of Walker Branch is affected by the OHW of Cape La Croix Creek. There are two adjacent wetlands present, one is a forested wetland area at creek mile 1.1 and while the second is two cutoff meanders (unconsolidated bottom) at creek mile 2.5 (PLATE I-2).

SECTION 404(b)(1) EVALUATION

I. PROJECT DESCRIPTION.

3. Location. The initial focus of the Cape Girardeau-Jackson Study was on a 210 square mile area shown on PLATE A-1. For economic reasons, the region of the present detailed investigation (Stage 3) was limited to the Cape La Croix Creek Drainage Basin (PlATE F-2). Cape La Croix Creek has its headwaters in steep hills located about 4 miles north of the city of Cape Girardeau, Missouri. From there it flows southward through the city to its confluence with the Mississippi River at river mile 50.2. The Cape La Croix watershed covers an area of about 21.4 square miles and has an average slope of about 29.5 feet per mile. The upper part of the basin (above the north crossing of US Highway 61 over the creek) is very steep, and only sparsely developed. Most of the area is wooded or in open pasture with only scattered residential and agricultural development. Between the north Highway 61 and Bloomfield Road crossings over Cape La Croix Creek, there is extensive urban development, this includes residential, commercial, industrial, and park land areas. Open bottomland is also present in certain sections. Walker Branch, the major tributary to Cape La Croix, enters the creek within this reach. The Walker Branch region is highly developed with residential areas upstream and commercial areas downstream of Broadway. The joint flood plain of Cape La Croix Creek and Walker Branch has been severely encroached upon with development extending out to the high banks in many cases. South of Bloomfield Road, development is not as heavy with more open bottomland available. Flooding from Cape La Croix Creek and Walker Branch generally occurs in the spring and summer months as a result of intense thunderstorms, although flooding may occur during any month of the year. These floods have a rapid rate of rise and are of a short duration, but as recent years have shown, they are capable of causing tremendous damage. Backwater from the Mississippi River entering Cape La Croix is considered minimal in terms of property damage.

TABLE I-1
ORDINARY HIGH WATER ELEVATIONS FOR SPECIFIC STREAM LOCATIONS ALONG CAPE LA CROIX CREEK BELOW THE HEADWATERS

Location	Elevation (OHW, ft. m.s.l.)
Mouth of Creek at Mississippi River	334
Sprigg Street	334
Missouri Route 74 bridge	340
Lower US Highway 61 bridge crossing	350
Hopper Road Bridge	360
Upper US Highway 61 bridge crossing	370
Highway W bridge (.75 mile above upper US Highway 61 bridge)	381

4. General Description. The component features of the recommended flood control plan are as follows:

Features Affecting Waters of the US
to Which the 404(b) Guidelines Apply

(a) 1.3 miles of earthen channel enlargement along Cape La Croix Creek between creek miles 3.76 and 5.11.

(b) 1.0 mile of enlarged and concrete-lined Cape La Croix Creek channel between creek miles 2.76 and 3.76.

(c) An aquatic habitat structure along Cape La Croix Creek, located at creek mile 3.70.

(d) 0.4 mile of enlarged and concrete lined Walker Creek channel between creek miles 0.00 and 0.40.

Features Affecting Waters of the US but
to Which the 404(b) Guidelines are not Applicable

(e) 78 acre upland dry detention reservoir and dam.

(f) 0.5 mile of enlarged and concrete lined Walker Creek channel between creek miles 0.40 and 0.89.

(g) 1.1 miles of earthen channel enlargement along Walker Branch between creek miles 0.39 and 2.00.

Features not Affecting Waters of the US

(h) 7 bridge replacements.

(i) 8 bridge removals.

(j) 14 acres of flood plain cleared of building structures.

(k) 13 miles of recreation trails.

(l) 81 acres of new park/EQ lands.

(m) 50 acres of riparian tree corridor.

5. Only features (a) through (d) involve the placement of dredged or fill material that is subject to Section 404(b) analysis as determined by the headwaters, OHW, and adjacent wetlands. It is the determination of the St. Louis District that features (e) through (g) are authorized by the nationwide permit published in 33 CFR 323.4-2, and will not require individual authorization. Discharges of dredged or fill material

required for construction, operation, and maintenance of these three features will satisfy qualifying criteria specified in 33 CFR 323.4(b). Features (h) through (m) do not involve the discharge of dredged or fill material into waters of the United States.

6. Authority and Purpose. The Cape Girardeau-Jackson Project resulted from three congressional resolutions. The first resolution, adopted in 1966, authorized a study of flood control and allied purposes for the area along the Little River Diversion Channel between Hubble Creek and Ramsey Branch, Cape Girardeau County, Missouri.

7. The second resolution, adopted in 1972, authorized a study of flood control and allied purposes along Cape La Croix Creek, Cape Girardeau County, Missouri.

8. The third resolution, adopted in 1972, authorized a review of recommendations of the Chief of Engineers on the Mississippi River between Coon Rapids Dam and the mouth of the Ohio River. Recommendations included Cape La Croix Creek and other waterways of Cape Girardeau County in a consideration of the needs for flood control, wise use of flood plain lands, . . . and other measures of enhancement and protection of the environment in the metropolitan area.

9. Description of the Proposed Discharge of Dredged or Fill Materials.

a. General characteristics of material. The characteristics of earthen, concrete, stone, and rock materials are described in the following paragraphs.

(1) Earthen material. Silt and clay material, high in organics would at first be excavated, and then partly used as backfill along the outside walls of the concrete channel.

(2) Concrete material. Poured gravel and cement aggregate would be used to line the bottom and sides of those sections of enlarged channel within the developed sections of Cape Girardeau. Concrete would also be used to construct the aquatic habitat structure.

(3) Stone material. Limestone less than 3 inches in diameter would be used as filter material beneath the concrete channel, and as bedding material for riprap areas.

(4) Rock material. Limestone rocks up to 350 lbs. top size would be used as riprap in the transition area between the Cape La Croix grass and concrete channel sections, and the transition area immediately below the concrete channel on Cape La Croix Creek. In addition, limestone rocks averaging 900 lbs. (maximum 3,000 lbs.) would be deposited to create the aquatic habitat device at creek mile 4.30.

b. Quantity of material proposed for discharge. See TABLE I-2.

TABLE I-2
QUANTITIES OF DREDGED OR FILL MATERIALS

Location	Earthen Excavation (CY) a.	Earthen Backfill (CY) b.	Stone Bedding Material (Ton) c.	Riprap (Ton) d.	Concrete (CY) e.	Stone Filter Material (Ton) f.	Quarry Run Rock (Ton) g.
Cape La Croix Creek							
Concrete Channel (R.M. 2.76-3.76)	140,200	22,300	390	780	22,520	53,100	0
Habitat Structures (R.M. 3.70)	1,800	0	0	0	10	0	700
Grass Channel (R.M. 3.76-5.11)	416,800	0	0	0	0	0	0
Walker Branch							
Concrete Channel (R.M. 0.00-0.40)	14,000	3,885	0	0	7,100	12,810	0
Totals	572,800	26,185	390	780	29,630	65,910	700

Note: Column (a) indicates the volume of material associated with the initial channel enlargement; columns (b-g) indicate the approximate volume of materials that would be deposited below OHW.

c. Source of material.

(1) Earthen material. This fill would be obtained during channel enlargement by excavating the sides of the existing channel. The creek bottom will not be lowered.

(2) Concrete material. Poured concrete composed of uncontaminated, locally obtained material.

(3) Stone/rock material. Would be obtained from nearby limestone rock quarries.

10. Description of the Proposed Discharge Site(s) for Dredged or Fill Material.

a. Location and areal extent.

(1) The locations being considered for channel enlargement extend between Cape La Croix Creek miles 2.76 and 5.11, and between Walker Creek miles 0.00 to 0.40.

(2) Concrete fill covering approximately 9.1 acres would be discharged along the bottom and vertical sides of a channel placed through the developed reach of Cape La Croix Creek between miles 2.76 and 3.76. The aquatic habitat structure located at Creek mile 3.70 would require a small amount of concrete fill. Concrete would cover 2.9 acres along Walker between creek miles 0.00 to 0.40.

(3) Stone fill would be placed beneath the concrete channels described in (2) above and would have the same area coverage.

(4) Rock fill covering less than one acre would be placed along the earth channel/concrete channel transition zone near Cape La Croix Creek mile 3.76, and along the concrete/unmodified channel transition zone near Cape La Croix Creek mile 2.76.

b. Type of disposal site.

(1) Earthen fill. The total amount of excavated material from the channel will be 572,800 cubic yards. Approximately 5 percent of the total would be placed as backfill to the new concrete channel walls (total strip coverage of 2.0 acres) and confined from the creek waters by the walls. The remaining excavated material will be deposited to 12 ft. high on approximately 30 acres of land. Potential disposal sites are shown on PLATE I-3. Final selection will occur during the project's design phase. The areas are above OHW, away from wetlands and sensitive bottomland.

(2) Concrete fill. Once hardened, this material is self confining.

(3) Stone fill. The filter material placed under the bottom of the concrete channel is confined from the surface waters by the impervious nature of that channel. Bedding material beneath the riprap areas would essentially represent an open water form of disposal.

(4) Rock fill. Riprap will also represent an open water disposal.

c. Types of habitat. The creek sections within the affected area have been subjected to recent flood control activities, including channel straightening, drag-lining and the removal of riparian vegetation. The present aquatic habitat value is quite low. The riparian corridor adjacent to the affected creek has a scant coverage of woody vegetation and is thus of limited value for food, cover, and as a travel lane for wildlife. The terrestrial area used for the permanent storage of the excess earthen dredged material (PLATE I-2) will be in open land habitat area (i.e., agricultural or old field settings). All proposed disposal areas are above OHW.

d. *Timing and duration of discharge*. *The disposal work* would begin near the year 1990 and would require approximately two years to complete. Operation and maintenance of the project would last for approximately 100 years.

11. Description of Disposal Method. Excavation and placement of material will be by means of heavy land-based earth moving equipment (drag-lines, backhoes, scrapers, dozers, dump trucks, etc.). Construction of the concrete channel bottom and walls will be done during the low flow period. Water flow will be relegated to one side of the channel by a small median dirt mound, the concrete bottom and wall will then be constructed on the dry side. Water will then be diverted to the completed side to allow work on opposite side of the channel. If the stream sediments are found to be contaminated, an alternate method of diversion will be used, such as a concrete culvert.

II. FACTUAL DETERMINATIONS.

12. Physical Substrate Determinations.

a. Substrate elevation and slope. Project channel bottoms would maintain their original invert and alignment, but would be somewhat flatter, wider, and generally more uniform. Side slopes would become smooth and vertical for the concrete channel areas and flatter (3:1 slopes) within earthen channel sections. The concrete aquatic habitat structure would rise 2 feet above the bottom of the upper end of the Cape La Croix concrete channel.

b. Sediment type. The existing substrate of the lower creek consists of silt/clay, high in organics. After its initial excavation,

this material would not be reintroduced to the creek except the dirt mound described in paragraph 11. Ultimately, the bulk of this material would be placed in a location above OHW while a smaller portion of the material would be confined as backfill behind the projects vertical concrete walls. Concrete, stone, and rock fill materials would permanently cover the existing sediment type in areas where it is used.

c. Dredged/fill material movement. All project materials are inherently (i.e., heavy riprap quarry run rock or hardened concrete) or locationally (i.e., stone beneath riprap or concrete, earthen material behind concrete walls or earthen material above OHW) protected from the effects of water flow except the dirt mound used to divert the stream temporarily during construction of the concrete bottom.

d. Physical effects on benthos The benthic community would be destroyed in all project areas where stone, rock, and concrete fills are applied (approximately 14 acres). Downstream sedimentation caused by channel excavation could result in an indirect covering of benthic organisms. Aquatic inventory data collected from the lower creek suggests that such impacts as these may be only moderately significant. This area has already been subjected to various flood control efforts that have reduced the physical diversity of the habitat necessary for the support of a diverse group of aquatic organisms. Long-term impacts would be somewhat diminished in earthen channel areas by the process of recolonization.

e. Other effects. Increased water velocities and reduced erosion within the channelized areas could result in downstream scour and bank erosion.

f. Actions taken to minimize impacts. All material not used in construction would be deposited in confined land disposal sites which would be designed to control the quality of return effluent. This would ensure that receiving waters are not adversely affected. Retention dikes, grading and seeding are among the appropriate measures that would be utilized as needed. During the detailed design phase of the project, consideration would be given to riprap and energy dissipating features to control any possible downstream scour and bank erosion. In addition, testing will be conducted in areas where a concrete bottom will be constructed to determine if contaminants are present. If they are present, the dirt mound will not be used to divert the creek.

13. Water Circulation, Fluctuation, and Salinity Determinations.

a. Water. No significant impacts.

(1) Salinity. Not applicable.

(2) Water chemistry. Sediment data was not included in the 1975 water quality report by Southeast Missouri State University (see

main report). However, the 1975 report classifies the bottom type as soft and murky and high in organics. The St. Louis District will test for the presence of contaminants before designating that the concrete lined channel portion of the creek be diverted by using a dirt mound scooped up from the stream bottom. If contaminants are present, an alternate method of diversion will be used. To date, the Missouri Clean Water Commission (MCWC) has indicated that a sediment resuspension may not be required for the project area. During the design phase of the project, the District will more fully coordinate this aspect with the MCWC and testing will be performed as needed.

(3) Clarity, color, odor, taste. These parameters will experience short-term impairment during construction. However, the effects will dissipate rapidly and are not expected to be detectable below the confluence of Cape La Croix Creek with the Mississippi River.

(4) Dissolved gas levels. Due to the high organic composition of the sediment, disturbance of this material could cause a short-term change in dissolved gas levels. This effect would occur only during the time of channel construction.

(5) Nutrients. Due once again to high organics, some release of nutrients into the water column can be expected during construction. This impact would disappear after project construction.

(6) Eutrophication. Not applicable.

b. Current patterns and circulation.

(1) Current patterns and flow. Current patterns would not be altered. The dry detention reservoir on Cape La Croix Creek would decrease downstream flood flows, even with the proposed channelization completed. But any decreases would only be slight during flood events due to the combined effect of the improved channel and dry detention reservoir. Walker Branch flow would increase within channelized sections, since there would be no upstream reservoir, but this would amount to less than 200 cfs. Because of the increased width of the earthen channel section, water depths could become reduced during low water stages. The 2-foot high aquatic habitat structure should help to minimize this problem, at least within the lowest portion of this reach.

(2) Velocity. Water velocities will increase within channelized areas during periods of heavy precipitation, although the enlarged width of the channel will lessen the degree of increase. Below the concrete channel velocity increases during flood stages would range from 2-6 feet per second depending upon the section of channel and the flood profile. Increases of up to 8 feet per second are expected in such instances near bridges.

(3) Stratification. Water flows should remain sufficient during and after project construction to prevent stratification.

(4) Hydrologic regime. Because of the impervious nature of the concrete channel, the natural gaining and losing process with the local ground water supply will be lost in these reaches. However, the prime recharge area for the Cape Girardeau water supply system is not Cape La Croix Creek, but rather the Mississippi River. While areas adjacent to the proposed channelization area currently act in the storage of flood waters from Cape La Croix Creek, the existing developed land uses in this area is not compatible with such hydrologic functions.

c. Normal water level fluctuations. There will be marked decreases in flood stages in the vicinity of the channelized area but these would vary with profile. Average decreases would be 2 ft. for 2-yr. profile, 1 ft. for 10-yr. profile, 2 ft. for 100-yr. profile, 2 ft. for 500-yr. profile, and 1 ft. for standard project flood. Creek stages upstream and downstream of this area would not be significantly altered (see water surface profile data, APPENDIX D). No significant change in the flushing characteristics of the two lower creek wetland areas is likely.

d. Salinity gradients. Not applicable.

e. Actions that will be taken to minimize impacts. Testing for presence of contaminants will be conducted where mounding of dirt to divert the stream channel would be used to construct a concrete channel bottom. If contaminants are present, an alternate method of stream diversion will be used. Construction of aquatic habitat structures would minimize water level reduction effects along the proposed wider earthen channel section. Further study would be conducted in the design phase of the project relative to the need for placing energy dissipators below the channelized area for the purpose of reducing the effects of any increased water velocity.

14. Suspended Particulate/Turbidity Determinations.

a. Expected changes in suspended particulates and turbidity levels in vicinity of disposal site. Suspended particulates and turbidity levels would be high during the construction phase of the project, and would diminish to ambient levels shortly after project completion. Specific sources of the suspended particulates include: (1) excavation of earthen material, (2) placement of forms for the pouring of concrete, (3) fines released during the deposition of rock and stone materials, and (4) the release of existing sediment materials following the dumping of rock and stone fills.

b. Effects (degree and duration) on chemical and physical properties of the water column.

(1) Light penetration. Light penetration would be affected only on a temporary basis. This effect would be due to increased turbidity resulting from project related dredging and filling activities.

(2) Dissolved oxygen. Dissolved oxygen may decrease briefly during project construction as a result of the introduction from the sediment of organic and possibly other chemical oxygen demanding substances.

(3) Toxic metals and organics. A resuspension test will be conducted during the design phase of the project in order to indicate the likelihood of introducing these substances into the water column by using mounded dirt to temporarily divert the stream channel during construction of the concrete channel bottom. If these substances are present, an alternate method of stream diversion will be used.

(4) Pathogens. No significant human usage of the lower creek (e.g. drinking water, primary contact recreation, etc.) is known to occur; therefore little potential exists for human contact with any pathogenic organisms the creek may contain. Construction should have little or no effect on pathogenic organisms.

(e) Aesthetics. Increased turbidity during construction will have only a minor visual impact, since the developed and developing lower creek already lacks significant aesthetic appeal.

c. Effects on biota.

(1) Primary production, photosynthesis. The normally low velocity of the creeks in the sections to be developed permits the growth of abundant phytoplankton. Any expected increase in velocity because of channelization would lower phytoplankton levels within these reaches. Increased turbidity as a result of construction would be temporary and the effect of lowering primary productivity at and below the channelized section would be brief.

(2) Suspension/filter feeders. Suspension of particulates and increased turbidity levels during construction may cause minor short-term impacts to filter feeders. Although, those organisms to be impacted are of necessity somewhat adapted to the natural high turbidity levels of the lower creek. When construction is complete, turbidity levels should subside to existing levels.

(3) Sight feeders. Sight feeders (e.g., most fish and some invertebrates) would be less successful in locating prey because of the covering of benthic organisms from increased bottom sedimentation and by the lowering of the visibility of prey within the water column as a result of increased turbidity. The turbidity and sedimentation increases

are expected to be brief and levels should return to near normal and allow a high degree of recovery and recolonization by sight feeders within affected areas after construction.

d. Actions taken to minimize impacts. Short-term construction related increases in suspended particles and turbidity are unavoidable. However, every effort would be made to use disposal methods that would minimize such turbidity, and, if possible, construction would take place during low flow stages to further minimize the levels. A resuspension test will be done in order to determine if contaminants are present. Future levels of turbidity would be minimized by the decreased flood flows as a result of the dry detention reservoir and the reduction of erosion by the use of riprap shoring, and revegetation of riparian habitat along grass-lined channel sections.

15. Contaminant Determinations. Since the vast majority of channel excavation will involve dry earthen material, contamination is not expected to be a problem. However, testing will be conducted to determine if contaminants are present in the stream reaches where a concrete channel will be constructed by using dirt scooped from the bottom to temporarily divert the stream to the opposite side of the channel. If contaminants are present, an alternate method of temporary diversion will be specified. This testing will be conducted during the design phase of the project.

16. Aquatic Ecosysystem and Organism Determinations.

a. Plankton effects. Immediate destruction to these populations would occur during project construction. Reestablishment of these populations would occur in the long-term but probably at a reduced level.

b. Benthos effects. Sedimentation during construction activity could cover benthic organisms. Concrete, stone, and rock fills would likewise cover organisms.

c. Nekton effects. Fish in the lower creek would suffer from the physical disruption of the creek's habitat during construction. Food and cover sources would be temporarily impacted. Such populations would be expected to quickly reestablish in the area following construction.

d. Aquatic food web effects. The removal of riparian vegetation will disrupt the aquatic food webs and reduce total aquatic biomass as a result of the loss of terrestrial energy inputs. Areas lacking deciduous forest vegetation commonly have low diversities and numbers of aquatic invertebrates. Disruption of the food chain will occur primarily in the area of channelization and especially during construction. Long-term impacts will be lessened as gradual community recolonization is likely to attain or surpass existing levels in reaches allowed to undergo natural revegetation. In the more improved sections, the concrete channel bottom

would not provide a substrate highly conducive to the production of benthos. However, flood control efforts on the part of the local sector may impact the food-chain even without a project.

e. Special aquatic sites effects. There are no special aquatic sites impacted.

f. Threatened and endangered species. The bald eagle and peregrine falcon may occasionally utilize the project area, but no habitat critical to the existence of either species is present.

g. Other wildlife. During project implementation, terrestrial wildlife will show a decrease in diversity due to the action of vegetation removal and the loss of aquatic food organisms. Long-term impacts would be less significant since some degree of reestablishment by vegetation and aquatic forms is expected.

h. Actions to minimize impacts. The previously mentioned measures for minimizing the projects physical and chemical disruptions would also benefit the biological system.

17. Proposed Disposal Site Determinations.

a. Mixing zone determinations. Not applicable.

b. Determination of compliance with applicable water quality standards. Water quality standards adopted by the state of Missouri and published in the Missouri Code of State Regulations, Title 10, Division 20, Chapter 7, are applicable to the proposed work site. Missouri's water quality standards define the state Clean Water Commission's water quality objectives in terms of water uses to be maintained and criteria to protect those uses, and defines the antidegradation policy. They were developed in accordance with Sections 303(c)(1) and (2) of the Clean Water Act which required that state water quality standards be reviewed and upgraded at least once every three years. Such revisions are pursuant to the national interim goal of protection of fish, shellfish, wildlife and recreation in and on the water by 1 July 1983, as outlined in Section 101(1)(2) of the Clean Water Act. It is expected that the placement of fill materials in connection with the proposed project would comply with state water quality standards. Excessive turbidity levels would be temporarily induced in local areas during construction.

c. Potential effects on human use characteristics.

(1) Water supply. No serious effects would be realized on any municipal water supply intakes within the project area, since none exist within the stream.

(2) Recreation and commercial fisheries. Sunfish and bullheads probably provide a minor degree of recreational fishing interest within the project area. Such fishing would be impacted during the projects construction and for some time after construction. The fish species to be impacted by channelization in the lower portion of Cape La Croix Creek are largely of the flood plain and transitional faunal groups. These groups characteristically have rather broad ecological requirements, are fairly pollution tolerant and are less susceptible to habitat disruption as a result of flooding or human activities.

(3) Water-related recreation. No such activity is known to occçur within the project area. Due primarily to its small size, the creek is not suitable for such activities as boating and swimming.

(4) Aesthetics. Short-term impacts on aesthetic values would occur at the worksite due to increases in turbitidy, the presence of construction equipment, and the disturbance of land areas on the creek banks. Long-term impacts would occur from an increase in channel uniformity and the deposition of concrete fill and riprap material would lower the visual attractiveness of Cape La Croix Creek within the project area.

(5) Parks, national and historic monuments, national seashores, wilderness areas, research sites, and similar preserves. Arena City Park lies adjacent to one section of channelized creek, but would not be significantly impacted by the project.

18. Cumulative Effects on Aquatic Ecosystem. All project impacts would occur within the lower portion of Cape La Croix Creek; the habitat of this area has already been degraded by channel straightening and drag-lining activities. Since no channel alterations have occured within the upper creek and no other major construction projects are currently authorized or pending, this action does not appear to have commulative implications for the aquatic ecosystem.

19. Determination of Secondary Effects on the Aquatic Ecosystem. Numerous secondary impacts are associated with stream channelization. Major concerns include elevated sediment loads, increased water temperatures, and decreased habitat diversity. Such changes produce a synergistic effect that results in a reduction in both fish and vertebrate populations and species diversity.

III. FINDING OF COMPLIANCE FOR CAPE GIRARDEAU-JACKSON STUDY PROJECT.

20. No significant adaptations of the guidelines were made relative to this evaluation.

21. The present Stage 3 Report for this project addresses an array of project alternatives ranging from a nonstructural plan to structural

plans more similar to the recommended plan. All structural alternatives require the placement of a fill material behind concrete channel walls but this assessment specifically addresses placement of fill material associated with the recommended or selected plan only. For more details concerning procedures of planning and designating, refer to Main Report (APPENDICES A and B.)

22. The planned placement of fill material is not expected to violate any applicable state water quality standards. The District will more fully coordinate this aspect with the Missouri Clean Water Commission during the design phase of the project. The proposed placement of fill material is not expected to result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreation and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. The life stages of aquatic life and other wildlife will not be adversely affected. Highly significant adverse effects on aquatic ecosystem diversity, productivity and stability, and recreational, aesthetic, and economic values will not occur.

23. Use of the proposed disposal sites will not harm any endangered species or their critical habitat.

24. With regard to the fill materials used and their placement, the construction of a dry detention reservoir, and the poor existing condition of the area, the recommended plan would inherently have a relatively low impact on the aquatic environment. Added measures to minimize impacts would include retention dikes to confine excavated earthen fill above OHW with seeding and grading, 2-ft. high aquatic habitat structure, the encouragement of natural revegetation in certain sections, riprap shoring in transitional zones, and resuspension testing in the area where the concrete-lined channel would be constructed. In addition, energy dissipaters would be considered.

25. The proposed placement of fill material complies with the requirements of these guidelines with the inclusion of appropriate and practical conditions to minimize pollution or adverse effects to the affected aquatic ecosystem.